THE PREPARATION OF REPORTS

SCIENTIFIC • ENGINEERING
ADMINISTRATIVE • BUSINESS

By

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PREFACE

As the term is used in this volume, the word *reports* refers to special and periodic communications employed to convey information through certain literal and graphic elements the character of which is determined by the nature of the facts presented. Such documents are indispensable today in practically all work of a scientific, engineering, financial, or administrative character. Because of the complexity of business and professional life in the twentieth century, those charged with the responsibility of large undertakings are seldom able to investigate personally the matters with which they must deal. Consequently reports from consultants or from subordinates frequently form the basis of highly important decisions, often involving heavy commitments. Under these circumstances the need of training in the preparation of reports is generally recognized by those who have achieved positions of responsibility. This training may well begin in the college or the university.

Ability to construct a satisfactory report should not be confused with rhetorical cleverness. A report must be so built as to carry the right view of a matter perhaps highly technical in nature to readers who have no first-hand knowledge of the case. Moreover, if there should be dispute or litigation, it will be subjected to constant criticism. Its author will be held strictly to the letter of what he has written. In developing his report he must therefore have a clear realization of its character and purpose in relation to the conditions from which it springs.

On the other hand, mastery of this kind is not alone sufficient. Many reports are so crudely organized that the effects produced by them are jumbled and chaotic. It should not be forgotten that the laws of design — the principles which govern the transmission of thought—are as vital as the facts themselves. Nor should it be forgotten that reports are the

records of modern thinking in the first state, the raw materials out of which science and philosophy and literature grow, and that, in the future, historians will turn to business reports as well as to political speeches for the bases of their generalizations. Today writers of reports are often more than recorders and interpreters of statistics; they are creators of vast industrial enterprises and originators of significant social changes which may affect the lives of countless people. As such, they are under obligation to be constantly alert to their responsibilities and high-mindedly determined to think clearly and to write honestly and effectively.

The experience of specialists in various fields has led to substantial agreement regarding the structural aspects of reports. Until the publication of the first edition, these features had never been treated comprehensively. The volume was therefore prepared to meet the need for a systematic analysis. In the present edition an attempt has been made to deal with the subject from as many points of view as possible, to furnish up-to-date illustrations, and to stress those qualities of sound organization and effective composition which are essential to success in any type of literature. One phase worthy of note is the excellent quality of prose in many of the extracts, which are drawn from numerous sources. In the first edition emphasis was placed upon science and engineering. In the present edition the scope has been broadened by the introduction of examples from economics and business. Inevitably, also, in view of the ever-increasing activities of governmental agencies, public reports have assumed a new prominence. The range of the volume therefore reflects tendencies apparent in the realm of higher education, where science, engineering, economics, business, sociology, and psychology all contribute to the training of men to meet the demands of the modern world.

Although the plan of the first edition has been retained, a large portion of the text is entirely new; and most of the illustrations have been replaced. Particularly worthy of mention are the sections on the use of statistics, the annual report, and the market survey. The authors have been fortunate in

securing access to hundreds of private reports, and they have examined thousands of published reports of all types. If the book has any special merit, it is that, as Bacon said of Machiavelli, it indicates what men do rather than what they ought to do. In other words, it is a record of current practice according to the best practitioners; and it will be useful as a reference work long after the course in the preparation of reports is forgotten.

The methods described in it were first developed in a course offered to seniors in Rensselaer Polytechnic Institute. The chief difficulty encountered in such a course is the fact that students, unlike practitioners, whose reports spring from the tasks in which they are engaged, are naturally attracted by subjects with which they have only a superficial acquaintance. This difficulty can be overcome by permitting them to analyze a number of reports which will retain their interest and introduce them to the world of affairs; by showing them, in this way, how the material of a report affects its form; and, after they understand this relationship, by requiring them to prepare a series of reports upon topics which fall within the limits of their activities.

Among the happiest experiences of recent years, during which the authors have discussed hundreds of reports and the situations with which they deal, has been their association with men in widely separated fields. Without this generous collaboration, they could have made little progress. It is pleasant to recall the unfailing courtesy with which their requests for information have been received. Although it is impossible to name those—often leaders in business or industry—who have given them access to their files and papers, or even those, cited in the following pages, who have allowed them to quote from their work, it is possible to mention a few, not cited, whose assistance has been especially helpful.

To the first edition Professor Homer H. Nugent, of the Department of English in Rensselaer Polytechnic Institute, contributed many of the topics for the exercises. Most of these have been retained. Dr. Arthur Challen Baker, of the United States Bureau of Entomology, who followed the devel-

opment of the manuscript with illuminating advice and painstaking criticism, made many valuable suggestions, particularly in connection with the problems of research. From the beginning of the study, Miss Harriet R. Peck, Librarian of Rensselaer Polytechnic Institute, lent her aid. The text of the first edition was reviewed by Mr. Howard D. Clayton, Director in Charge of Production, Cluett, Peabody and Company; Mr. Calvin P. Eldred, Superintendent of Hollingsworth and Vose Company; Dr. Matthew A. Hunter, Professor and Head of the Department of Metallurgical Engineering in Rensselaer Polytechnic Institute; Dr. N. S. B. Gras, Professor of Business History in Harvard University; Dr. A. T. Lincoln, Professor of Chemistry and Chairman of the Department in Carleton College; and Dr. Arthur M. Greene, Jr., Professor of Mechanical Engineering and Dean of the School of Engineering in Princeton University. Since the main outlines of the book have not been altered, the present edition often reflects their experience and counsel. To them the authors owe their thanks.

Especially do they owe them to Major John Coffee Hays, Vice-President of the Stone and Webster Engineering Corporation, whose advice has added greatly to the value of the illustrations; to Messrs. K. G. Stuart and E. L. Kendrick, of the Eastman Kodak Company; to Mr. H. G. Weaver, of the General Motors Corporation; to the engineering staff of the Port of New York Authority, especially Messrs. C. W. Dunham, Ole Singstad, and G. M. Rapp; to Professors Erich Zimmerman and Gustav Schwenning, of the School of Commerce of the University of North Carolina, who have suggested numerous examples; and to Professors Edward H. Van Winkle and F. Darrell Moore, of Rensselaer Polytechnic Institute, who have read the chapters on statistics and annual reports.

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CHAPTER 1

ORIGINS AND FORMS

Development of Reports.—Reports, which are used to convey and, incidentally, to record information, have always passed between those who do and those who direct; between those who are concerned with details and those who are concerned with policies. As long, therefore, as men have been associated as employee and employer, as subordinate and superior, reports have been current among them. Since the dawn of civilization they have reflected changes, recorded achievements, and preserved data of inestimable value for the study of human progress. Few of these earlier reports have survived. In connection with this chapter, they are of interest only because they anticipate the process of evolution through which modern reports, essential in industrialized communities, have been developed. It is no exaggeration to say that the history of their development is the history of an epoch in the Western World.

Reports in Classical Times.—The earliest reports in existence deal with military expeditions, business transactions, and engineering achievements.

An early military report is the *Anabasis,* of Xenophon, which records the retreat of the Greeks from the heart of the Persian Empire about 400 B.C. Hundreds of business reports are to be found on the cuniform tablets and Egyptian *papyri* preserved in the great museums of the world. They are usually accounts of daily transactions, financial surveys, or routine inventories corresponding to modern annual reports. A good example of such a report appears in *Oxyrhynchus Papyri* (Vol. VI, No. 896).

Early engineering reports consist generally of recommendations regarding the construction or repair of dykes and buildings. The most complete report of the kind which has come

down from classical times is that by Frontinus on the water supply of Rome at 100 A.D. It is of incalculable value in the history of Roman engineering. Examination of this report shows that, like the reports written today, it opens with an authorization of the undertaking (Chapter 1), outlines the scope of the study (Chapters 2 and 3), and presents a brief historical account of the aqueducts (Chapters 4-23) of the city. Like a modern expert, Frontinus writes clearly, according to a definite plan, which is indicated in the passage below:

(1)

And that I may not by chance omit anything which is necessary for the understanding of the whole subject-matter, I will first put down the names of the waters which are brought to Rome; then by what persons . . . and in what year since the founding of the city each was brought in; then at what places and at what milestones their aqueducts commence; how far they are carried in underground channels, how far on masonry substructures, and how far on arches; then the height of each of them. . . .[1]

The report, which is filled with technical terms and specific figures, was probably illustrated and was certainly presented in attractive form.

That Roman engineers were accustomed to make reports at frequent intervals is evidenced by reference in Frontinus to at least six other reports dealing with the water supply, as, for instance, the recommendation report referred to in Chapter 104, with the Senate's order resulting from it:

(2)

The consuls Q. Aelius Tubero and Paulus Fabius Maximus, having made a report upon the number of fountains established by M. Agrippa in the city and adjacent to the city, have inquired of the Senate what it will please to order upon the subject; upon which it has been ordered: That the number of public jet fountains which exist at present . . . shall be neither increased nor diminished. Further that the water commissioners . . . shall take pains that the public jet fountains may as continually as possible deliver water for the use of the people day and night.

[1] Translation by Clemens Herschel (New York, 1913). Reprinted by permission of the publishers, Longmans, Green & Co.

Reports in the Fourteenth, Fifteenth, and Sixteenth Centuries.—Almost no reports remain from the period between the fall of the Roman Empire and the emergence of the modern era. At the beginning of the fourteenth century, the village system of economy still lingered in Europe. The relations which existed at that time between the land-working and the land-owning classes are fairly obvious. Like their classical predecessors, the foremen and bailiffs reported to the nobles regarding such matters as money rents, court fines, and inventories of herds, meadows, forests, and ponds. As town economy emerged in the fifteenth century, the patricians required from their agents occasional statements regarding the mines under their control; and the bishops received from their deputies similar accounts of the crops on their estates. In the sixteenth century, the great merchant houses, such as the Medici, of Florence, and the Fuggers, of Augsburg—the reports of whose agents have been recently translated[2]—kept careful records of the commercial, financial, and political developments in their trading areas; and as soon as the gallant adventurers—the Drakes and the Grenvilles, half-traders and half-pirates—who broke out the English flag on every sea, cast anchor at Plymouth, they invariably posted up hot-haste to London to announce their arrival to the worshipful companies for whom they sailed. Many of the narratives preserved by Hakluyt and Purchas are reports, in the modern sense, in spirit and almost in form. Aside from the quaintness of the language, little differentiates them from accounts of explorations in the twentieth century. There is a touch of modernity about *The First Voyage to Virginia* that marks the beginning of a new era:

(3)

The first voyage made to the coast of America, with two barques, wherein were captains M. Philip Amadas, and M. Arthur Barlow, who discovered part of the country now called Virginia, Anno 1584. Written by one of the said captains and sent to Sir Walter Raleigh, knight, at whose charge and direction the said voyage was set forth.

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[2] *Fugger News Letters* (London, 1924); Second Series (New York and London, 1926).

The 27th day of April, in the year of our redemption 1584, we departed the west of England with two barques, well furnished with men and victuals, having received our last and perfect directions by your letters, confirming the former instructions and commandments delivered by yourself at our leaving the river of Thames. And I think it a matter both unnecessary for the manifest discovery of the country, as also for tediousness' sake, to remember unto you the diurnal of our course, sailing thither and returning: only I have presumed to present unto you this brief discourse by which you may judge how profitable this land is likely to succeed, as well to yourself (by whose direction and charge, and by whose servants this, our discovery, hath been performed) as also to Her Highness and the Commonwealth, in which we hope your wisdom will be satisfied, considering that as much by us hath been brought to light as by those small means and number of men we had, could any way have been expected or hoped for.

Reports in the Seventeenth, Eighteenth, and Nineteenth Centuries.—As already indicated, few reports from the Medieval and Renaissance periods have survived. By the end of Elizabeth's reign, however, the importance of such records was generally recognized; and they became increasingly numerous. Following Bacon's advice in the *Advancement of Learning* (1605), men took pains to preserve every document of any value and to comment at length on economic, political, and scientific matters in letters, pamphlets, and treatises. The establishment of the Royal Society in 1660 gave a marked impetus to the publication of scientific reports and fixed the rudiments of a distinct style, based on the *genus humile* of the classical writers. Bishop Thomas Sprat, in his *History of the Royal Society* (1667), notes that the members were "most solicitous" in the "manner of their discourse," and that in their reports (Section XX) they "exacted from all their members a close, naked, natural way of speaking, positive expressions, clear senses, a native easiness; bringing all things as near the mathematical plainness as they can, and preferring the language of artisans, countrymen, and merchants before that of wits and scholars."

The painstaking memoranda of Samuel Pepys, administrator and diarist, on the state of the navy, and the far-reaching

plans of Sir Christopher Wren, scientist and architect, for the reconstruction of London after the Great Fire, follow carefully the suggestions of the Royal Society, of which they were both members. With the beginning of the Industrial Revolution in the eighteenth century, the problems treated in reports became more intricate and more difficult. The relations between employee and employer approached, for the first time, those which exist today. As a result, James Watt, machinist and inventor, found it necessary to keep his partner, Matthew Boulton, financier and man of affairs, informed of the progress of his experiments. Writing to another of his friends in 1765, he remarked:

(4)

I have now almost a certainty of the *facturum* of the fire-engine, having determined the following particulars: the quantity of steam produced; the ultimatum of the lever engine; the quantity of the steam destroyed by the cold of its cylinder. . . . If there be not some devil in the hedge, mine ought to raise water to 44 feet . . . which I think I can demonstrate. I can now make a cylinder 2 feet in diameter and 3 feet high, only a 40th of an inch thick, and strong enough to resist the atmosphere; *sed tace.*

The aspects of the situation suggested by this extract are constantly duplicated under modern conditions. Again, John Smeaton, engineer and contractor, who built the Eddystone Lighthouse, the Perth Bridge, and the Clyde Canal, wrote numerous professional communications, republished in three volumes as *Reports Made on Several Occasions* (London, 1797, 1812, 1837), which are remarkable for the skill with which the most technical subjects are discussed in the language of the coffee house. By the nineteenth century, then, the report had become a facile instrument ready for the hands of investigators such as Michael Faraday, who published his *Experimental Researches in Electricity* in 1839-1855. The writers of the twentieth century have merely given to the type a recognized technique.

Medieval and Modern Reports: Essential Differences.—The differences between reports in the thirteenth century and

those in the twentieth can be indicated most easily by a contrast between industrial conditions in the two periods. Under the handicraft system of manufacture, the owner of a plant himself acted as superintendent. His employees were few; his concerns seldom reached beyond the nearest market town; his relations with his assistants were intimately personal, and the communications — informal, brief, and simple — which passed between them were invariably oral. Today the corporation has succeeded the individual. In one sense, the manager is little more than a link between workers and stockholders. Employees number thousands; enterprises reach into every state and country; business is impersonal, and the communications—formal, extensive, and complicated—which pass from official to official are invariably written. These communications are known as reports. In business and finance there has been less change. In the past the reports of agents kept the great commercial houses like the Contarini, of Venice, and, later, the East India Company, informed of conditions in distant territories. These reports were not based on scientific surveys, but they served the same purpose as the market analyses which are common today.

Professional Reports.—Although the relationship between employee and employer which led to the development of the report as a distinct type in literature still exists, and although it conditions innumerable reports, it is less significant now than that between expert and client. Industry has become so complex that executives are necessarily dependent upon specialists. Often these specialists are more highly educated and, especially if they have established themselves as consultants, are more highly regarded than those whom they serve. Their position is practically that of the physician or the lawyer. While both of these expect to be remunerated for their advice, their social standing is sometimes superior to that of those by whom they are retained. In every community, they are recognized as leaders. Whether an expert—an economist, a scientist, an engineer, an architect, an agriculturist, or a forester—is permanently or temporarily attached to an organization, whether he receives a salary or a fee, his status is that of an associate

and not that of a subordinate. This new relationship is emphasized by the character of the work undertaken in the course of a month by a firm of consulting engineers [3] in New York. During this time, in the words of its head, "it was completing for the investor an exhaustive experimental investigation of a new method for producing potash; reporting for a trading company on the prospects for a particular industry in Japan; examining for clients the record of tests of a new gas engine; appraising the equipment of a foundry; giving expert testimony in a patent case; framing a new building code for a nearby city"; suggesting plans for the "reorganization of a manufacturing business in Vermont; preparing a brief for a New York State city; advising another municipality as to railroad relocation; conducting an industrial survey for the Chamber of Commerce of a large New England city," and studying "methods of garbage disposal in New Jersey." Altogether, its members were giving the benefit of their experience to about thirty corporations or communities.[4] Under such circumstances, the weight of responsibility falls upon the expert. This fact commits him to the stern code of ethics recognized by his fellows in other professions. He can escape neither the dignity conferred by knowledge and attainment nor the obligation imposed by confidence and trust.

Independent Reports.—In addition to reports written by employees for employers, and by experts for clients, many reports are now written independently. Instead of being addressed to readers who have paid for their preparation, they are addressed to those who may purchase them after their publication. Although it is true that their primary function is to inform and not to entertain, they often lead to an enjoyment similar to that produced by a work of history. To follow the harmonious development of an intricate theme is an intellectual delight. Nevertheless, pleasure is secondary. Those who read reports read them primarily for the facts which they contain. The results of investigations published as articles and

[3] The Technical Advisory Corporation.

[4] The mere index of the reports made before 1924 by Arthur D. Little, Inc., chemists, engineers, and managers, of Cambridge, Massachusetts, is a typewritten volume of 359 pages. These reports deal with almost every phase of industry.

treatises are fundamentally contributions to the stock of human knowledge. However fascinating these articles and treatises may be, they appeal, as a rule, only to specialists; but there appears to be no reason why they cannot be made as interesting to others. When their forms are more fully understood, those who are concerned with the extension of science and its application to industry may find that they have established a literature which rivals that of antiquity.

Already reports have influenced perceptibly the destinies of men. Every one is familiar with the effect of the memorandum forwarded by Alfred Wallace to Charles Darwin. Without the reinforcement of this memorandum, it is doubtful whether the latter would have proceeded with *The Origin of Species,* itself based on innumerable reports. In the pure sciences, it is not difficult to recall other communications that have altered the material and spiritual conceptions of the race. In the applied sciences—engineering, architecture, mining, agriculture, and forestry—are also studies which have affected the course of civilization: in engineering, for example, the report by the Board of Consulting Engineers which led to the construction of the present lock-canal across the Isthmus of Panama; that made by the Commission appointed to investigate the electrothermic processes employed in Europe in the smelting of iron ores and the manufacture of steel; that on a super-power system for the region between Boston and Washington, a study pointing to a closely integrated community stretching from Massachusetts to the District of Columbia; that on smoke abatement, prepared for the Chicago Chamber of Commerce, which has increased the comfort and health of innumerable municipalities; and that on noise, sponsored by the Noise Abatement Commission of New York City, which has already had an appreciable effect; in mining, the report on the nickel industry in the Province of Ontario; in architecture, the report of Sir Christopher Wren, already cited, which is reflected in the streets and churches of London; in agriculture, the report of the Reclamation Service on the drought areas; and, finally, in forestry, the recent report of the Forest Service on the methods by which the natural resources of the United States may be conserved.

These instances ought to emphasize sufficiently the part which the report is likely to play in the immediate future. With it as a means of communication, the specialist may exert an influence which has never been surpassed or even equaled.

Points of Similarity in Reports and Letters.—In their inception, reports written by employees for employers and by experts for clients differ from every type of literature except letters. They are not due to the universal desire for self-expression which has produced innumerable masterpieces; they are not due to the overwhelming interest in a particular subject that makes scholars or fanatics; nor are they due immediately to the economic urge which has always been a potent stimulant in Grub Street. Administrative and professional reports are prepared either as matters of course, in connection with the duties which the authors have undertaken to perform, or on particular occasions when information and assistance are especially required. Incentive comes ordinarily, therefore, from readers and not from writers. Since the former know exactly the facts which they desire, reports may be merely answers to a series of questions or completions of a number of blanks. For instance, the daily reports of the field parties engaged on the Cincinnati Underground Survey consist of replies to certain questions, arranged in tabular form, regarding the date, the number of the party, the kind of weather, the nature of the investigation, the character of the district, the extent of ground covered, the names of the assistants, the ways in which they were employed, the hours of work, and the expenses which were incurred. Similarly many business houses, industrial establishments, and engineering firms have developed elaborate systems, based on forms suited to particular conditions, by which it is possible to determine at a glance the volume of trade, the result of operation, or the progress of an undertaking at the end of a day, a week, or a month. Those to whom they are submitted are prepared, and even eager, to examine them. The relations between writers and readers are, therefore, paralleled only by those which exist between the parties to a correspondence regarding a subject of mutual concern. Indeed, written reports, treated in this volume, may be

defined as letters dealing with facts established by certain recognized procedures, to be explained later. Like letters, they are records of the past, mirrors of the present, and charts of the future; and, like letters, they reflect various conventions which have been found useful when communications must pass from one person to another through the medium of literature.

Reports Classified by Arrangement and Length.—As indicated in the last paragraph, these communications may properly be classified as *form reports,* those in which the order is fixed beforehand by the readers to whom they are to be presented, and *composition reports,* those in which the arrangement as well as the choice of material is left to the discretion of the authors. Since form reports are more dependent on the technique of administration than on the theory of rhetoric, this volume deals almost exclusively with composition reports. For convenience, they may be classified as: (1) short, (2) long.

Although no definite line of cleavage separates the two classes, the distinction is clear enough in actual practice, as the following sections show.

Characteristics of the Short Report.—If the material of an administrative or professional report does not extend to more than 5 pages, it is cast in the mold of an ordinary business letter. Because of this fact, a review of the elements and characteristics of the business letter may be helpful. They are:

1. The Heading.—(a) *Printed.* The printed heading contains the name of the writer, his address, and sometimes a characterization of his business: in short, whatever information regarding his personality and his office seems necessary to explain the origin of the communication. Taste restricts statements of professional qualification to the simplest details.

(b) *Typed.* If plain stationery is used, the heading, appearing in the upper right-hand corner within the established margins, contains the writer's address, with the smallest element first.

2. The Date.—The date is always entered on a separate line. It may be centered to balance a printed heading or it may appear directly above the inside address at the left-hand side.

It always gives the exact date—the year, the month, and the day—of composition.

3. THE SUBJECT.—For the convenience of the reader, it is customary to indicate definitely the subject with which the letter deals. It may appear centered above the address, on one line of the address, or centered below the salutation.

4. THE ADDRESS.—Facts regarding the addressee similar to those regarding the writer are necessary to make certain that the letter will be read by the person for whom it is intended. These facts serve as a means of identification.

5. THE SALUTATION.—A formal greeting has been established by custom.

6. THE TEXT.—(a) *The Contact.* The letter should be related to the correspondence with which it is connected. Contact may be established by reference to previous communications, either oral or written, which have passed between the writer and the reader, or to developments or interests which may justify the author's communication. Tact and adroitness in establishing contact often determine the success of a letter.

(b) *The Discussion.* Since the discussion is that part of the letter which differentiates the various types, any attempt at generalization is unnecessary.

7. THE CLOSE.—The close is a compliment fixed by custom. Like most conventions, it cannot be ignored without a suggestion of disrespect.

8. THE SIGNATURE.—The signature of the writer is more than a matter of courtesy. It is a legal bond fixing obligation and responsibility.

9. THE SUPPLEMENT.—Additional information regarding dictation or enclosure is often required. As a rule, this information would destroy the unity of the text if it were included in it. Enclosures are often numbered as appendices or supplements.

Within the limits set by these requirements, the short report may be either formal or informal. If it is (1) formal, the style will be influenced by the methods of tabulation in vogue

at the present time. If it is (2) informal, it will be less abrupt and occasionally more familiar in style.

An example of the formal type is the letter, reproduced below, from the late Rolla C. Carpenter, Consulting Engineer and Professor of Experimental Engineering in Cornell University, to the Bureau of Municipal Research:

(5)

Bureau of Municipal Research,
261 Broadway,
New York City.

Gentlemen:

I have given careful consideration to the estimates which you have made . . . as to the relative cost of lighting public buildings from an isolated plant located in the buildings as compared with the purchase of electrical current from a central company.

As a result of my investigation, I have reached the conclusion that the data upon which your calculations are based are conservative, reasonable, and correct for operating conditions, and that your method of calculating results from such data is correct and calculated to give estimates which may be realized in practice.

I especially refer to the following points relating to the data and the method of calculating costs in the problem under consideration:

(1) The problem to be decided obviously involves the additional cost due to the installation and operation of a lighting plant over and above the costs now incurred in the operation of the plant for heating, ventilating, pumping, etc. *Any estimate of the cost of operating an isolated plant for lighting which neglects consideration of the heating plant would be misleading.*

(2) The heating season averages more than 200 days.

(3) The heaviest lighting demand occurs during the heating season and about the time of the demand for most heat.

(4) Each square foot of radiator surface may be conservatively estimated as condensing ¼ pound of steam during the heating season.

(5) One square foot of radiation is required in heating buildings for 60 to 100 cubic feet of space, depending upon exposure.

(6) The evaporation of steam per pound of coal depends upon the quality of the coal, method of firing, etc. With small anthracite coal, an evaporation of 7.5 pounds of water for one of coal from feed water at 200 degrees F., steam at 220 pounds pressure, is a conservative and reasonable estimate. Better results can usually be obtained.

(7) Exhaust steam is nearly as valuable as live steam for heating purposes. Your estimate that 90 per cent of the steam supplied an engine is available for heating is fair and reasonable.

(8) The maintenance of high pressure steam sufficient to operate steam engines or turbines which exhaust into steam mains or into heaters does not require in practice more coal than to operate the plans with low pressure steam.

(9) My experience indicates that during the heating season the amount of steam required for heating is, except at rare intervals, much in excess of that required for the lighting engines under the usual requirements of a public building. It follows, therefore, that during the heating season additional fuel will seldom be required for the lighting plant.

(10) The question of additional help over and above that usually employed to operate the steam plant and also the fixed charges on the lighting plant are in my opinion conservatively stated in your reports.

Yours very truly,

(*signed*) Rolla C. Carpenter

It is hardly necessary to remark that, although this letter is a report on an investigation which had been completed at the time it was written, all that differentiates it from the average business letter is the arrangement of the ten "points" to which attention is directed. Later in this volume are a number of extracts from long reports which are almost identical in form.

An example of the informal type is the following letter from the late George F. Sever, Consulting Engineer and Professor of Electrical Engineering in Columbia University, to the Department of Water Supply, Gas, and Electricity of New York City.

(6)

MR. C. F. LARCOMBE,
Department of Water Supply, Gas, and Electricity,
13 Park Row, New York City.

My dear Mr. Larcombe:

I transmit herewith the tabulated results of the test made at the Tombs Prison. . . . The crucial facts that are brought out in this test are these: During the two days' run, there were used 228,276.3 pounds of water through the meter, and presumably in the boiler, while 11,219 pounds of coal were delivered to the boiler, this performance indicating an evaporation of 20.3 pounds of water per pound of coal, an amount which is entirely out of reason, and which indicates that something is wrong with the mechanical equipment.

Steam meters were placed on the steam services to the kitchen, the north shower baths, and the laundry and south shower baths. The sum of the indications of the three steam meters indicates a total consumption of water in the form of steam of 18,382.4 pounds. The amount deducted from the total pounds of water delivered through the water meter leaves 209,893.9 pounds of water which were used partly for the operation of the three pumps consisting of the boiler feed, the house, and the drip pumps. . . .

The normal evaporation in first-class boilers under good operating conditions is approximately 8 pounds of water per pound of coal, all of the water passing through the boiler being balanced against the total amount of coal used in the boiler.

The total number of kilowatt-hours used for lighting and power work during the two days was 136, as shown by the attached table.

Very truly yours,
(*signed*) GEORGE F. SEVER

It is clear that in this instance there is nothing, aside from the character of the text, to distinguish the letter from any other. Nevertheless, it is quite as definitely a report on the results obtained in the course of a particular investigation as is that by Professor Carpenter. The short report is, therefore, merely a report written in the form of a letter.

Exercise: A Short Report.—Prepare a short report, not more than two pages in length, on one of the following topics. Use the forms ordi-

narily employed in business correspondence and address specifically an intimate acquaintance whose knowledge of the subject you can gauge exactly. Include all essential points. For instance, in a report on the first topic under the heading *Miscellaneous*, consider, besides the amount, such matters as the brands of tobacco used; the methods—by cigarette, cigar, or pipe; the times of smoking, and, so far as possible. the reasons for indulgence.

Agriculture: An examination of the character of the soil on the campus; an exposition of the methods employed in mailing bees; a record of the amount of milk given by four cows during a fortnight; a study of the growth or yield of a plant (1) with or without fertilizer, (2) with or without irrigation; a study of the percentages of eggs hatched in incubators of different types; a study of the weekly yield of eggs from four breeds of poultry.

Commerce: An analysis of the weekly calls on a residential telephone; an examination of the drinking fountains in a public building, of the fire appliances on the campus, of the sanitary facilities in a factory, or of the recreation rooms in a plant; a memorandum regarding the shrinkage of the senior class during its four years in college; a statement and an explanation of weekly production of a small mill or factory; the financial statement of a bank; the current year's (1) production, or (2) consumption, or (3) import, or (4) export of a certain product; the management of a business enterprise, the capital structure of a corporation, the bonded indebtedness of a municipality, the workingmen's compensation system of the state, or the organization of a department in a factory or business organization.

Engineering: A chemical analysis, with appropriate explanatory data; a mineralogical assay; a comparison between the amounts of oil and gasoline consumed by two automobiles on a 20-mile course; an investigation of the efficiency of some type of apparatus; an inspection or test of any nature; a series of readings on a gauge or meter of any kind; an examination of one of the laboratories on the campus, of the system of campus walks and drives, of the outdoor lighting system, or of the central heating system; a record of the high-water marks of a stream during a freshet; a record of local temperatures during the current year; an analysis of the design of a bridge or other structure.

Forestry: A classification of the common forest trees in the neighborhood; a memorandum concerning the condition of a tree on the campus, the different species of trees in the neighborhood, the methods of controlling forest fires, or the prevention of soil erosion in cut-over lands.

Miscellaneous: An account of the tobacco used by a student during a week, of the examination system in vogue; an analysis of the menus at the dining hall during a week; a memorandum concerning the accuracy of a watch during a week or the material on the floors of a college building; a statement of the expenses of an athletic team on a trip, or

of the hours of (1) study, (2) sleep, (3) recreation during an average school week; an examination of ten selected letterheads, with comments; a comparison of selected handbooks in a field such as English Composition; an analysis of fraternity rushing rules, of eligibility rules, of requirements for degrees in three selected fields, or of the scholastic standing of four fraternities.

Science: An examination of a larva of any kind at the end of a stated period; an account of the poisonous plants in the neighborhood; a memorandum concerning mosquito control; an account of the geological formation of the region; an examination of the museum connected with a department of science or of the scientific apparatus for conducting definite studies regarding such subjects as radio-activity, atomic structure, cosmic or other rays, or sound phenomena; an account of the career offered in bacteriology, hygiene, geology, botany, psychology, physics, pharmacology, or entomology.

Characteristics of the Long Report.—In some instances, administrative and professional reports extending to several hundred pages appear as letters. The letter form is more common, however, in reports which do not exceed 100 pages. Excellent examples of this arrangement are to be found in the reports, made to the Congress by the Secretary of War, of investigations by the Corps of Engineers on river and harbor work. They usually consist of a series of letters beginning with the report of the District Engineer and culminating in a brief letter from the Secretary of War. The various letters are summarized at the beginning, and the topics to be considered are carefully enumerated. Similarly, the first part of the *Eighth Annual Report* of the Public Utilities Commission of Connecticut is a letter of 99 pages devoted to an interpretation of the seven hundred pages in the appendices. The preliminary paragraph illustrates a common form of opening:

(7)

The Public Utilities Commission herewith submits its eighth report, containing a summary of its actions on such petitions, complaints, and other matters as have been disposed of during the fiscal year . . . and a general review of the financial condition and results of operation of all public service companies under the jurisdiction of the Commission as ascertained from the returns of such companies for the calendar year. . . . Such returns in detail will be found in the several appendices to this report.

Although these illustrations are by no means exceptional, most writers of administrative or professional reports of any length tend to regard the report as a treatise or book and to restrict the conventions of the business letter to a brief introduction known as a letter of transmittal. This letter assumes different forms which are dependent upon the individuality of the writer and the immediacy or remoteness of his responsibility for the text and findings of the report. Inasmuch as they are a distinct element of modern long reports, they will be discussed at length in the following chapter.

Characteristics of Independent Reports. — Independent reports assume the forms and conventions of books and monographs. They substitute for the letter of transmittal to a definite reader or group a foreword to all who may be interested in the subject. It contains the material usually found in such prefatory sections. As the following example shows, forewords, which are discussed at greater length on pages 40 and 41, are brief, general commentaries, the chief purpose of which is to establish relations between writers and readers. References to aim, importance, interest, and scope are, therefore, more ample than in most letters of transmittal.

From *Practical Experience with Profit Sharing in Industrial Establishments,* National Industrial Conference Board Research Report 29 (New York, 1920):

(8)

FOREWORD

There is widespread interest among industrialists in the United States and abroad in the subject of profit-sharing, and numerous establishments have recently adopted plans in this field. The National Industrial Conference Board therefore undertook a country-wide inquiry into the subject. The results of experience, both past and present, with profit-sharing and its allied forms have been studied through printed sources, extensive correspondence, and considerable field work. Although the inquiry has been confined to manufacturing establishments, it is felt that in this way experience with profit-sharing and its allied forms has been analyzed in its most significant application.

The purpose in view in undertaking this investigation has been to determine so far as practicable from actual experience the causes and circumstances which make some profit-sharing plans fail and others succeed. No attempt has been made to pronounce judgment on profit-sharing as tending toward copartnership in industry, and only such conclusions are drawn as practical experience with plans in operation and abandoned will justify.

Facts Established in This Chapter.—In summary it may be said that reports have, since the dawn of civilization, recorded facts upon which executives might base future action and that they have reflected the growing complexity of modern life both in their increased numbers and in their tendency toward standardization in form. Modern reports, whether short or long, reflect the conventions of business correspondence. If they are short, they reflect them throughout; if they are long, they reflect them in brief introductions known as letters of transmittal. Independent reports omit the conventions of the letter but retain the substance in sections known as forewords.

Since short reports are really letters dependent on the procedures adopted in the preparation of long reports, succeeding chapters are devoted exclusively to the second type.

CHAPTER 2

ELEMENTS

Units of the Report.—Long reports, to which this volume is chiefly devoted, comprise a number of distinct units: the title page, the table of contents, the letter of transmittal or the foreword, sometimes the letter of authorization, the letter of submittal, the epitome, the text, the appendix, and the index. Some of these units are indispensable, and all of them appear in most reports. For this reason, it seems advisable to consider them together in a single chapter.

Title Page: Regular Forms.—The title page contains most of the information found in the parts of the letter devoted to the heading, the address, and the statement of the subject. As a rule it includes (a) the title of the report, (b) the name of the person or organization to whom the report is addressed, (c) the name of the author, and (d) the place and date of writing or publication. Its function is to relate the report to the parties concerned and to established it in the proper perspective. Two forms—one used when a report is (1) typed and one used when a report is (2) printed—have been developed in practice.

The form employed in manuscript is illustrated by (1) on the following page.

Although typing precludes the variations possible when the title page is printed, spacing, capitalization, and underscoring may be used to give balance and proportion. The title is usually preceded by the words "Report on" or "Report upon."

When a report is printed, the form of the title page is influenced perceptibly by that used in books and pamphlets. Although the facts included are substantially those mentioned in the last paragraph, the order is often different. The arrangement consists of a short title, such as is found on the backs

(1)

Report Upon

FEASIBILITY AND CONSTRUCTION

of

THE ARROW LAKE DAM

Made to

THE PIONEER DEVELOPMENT COMPANY

By

GEORGE FRENCH DUNTON

Consulting Engineer

June 15, 1932

New York City

of bound volumes; the full title, which is usually much longer, and which contains a reference to those who are responsible for the undertaking; the name of the author, and the place and date of publication. An illustration of such a title page is shown on the opposite page.

(2)

SMOKE ABATEMENT

AND

ELECTRIFICATION OF RAILWAY TERMINALS
IN CHICAGO

REPORT OF

THE CHICAGO ASSOCIATION OF COMMERCE
COMMITTEE OF INVESTIGATION ON SMOKE ABATEMENT AND ELECTRIFICATION OF RAILWAY
TERMINALS

W. F. M. GOSS, Chief Engineer

CHICAGO

1915

Title Page: Special Forms.—Variations, employed in manuscript and occasionally in print, are not uncommon. The first variation is that ordinarily used in interdepartmental routine in commercial and industrial establishments. It is seldom adopted, however, unless the text is informal and, to some extent, confidential. An example is shown in (a) below. The second variation, an example of which is shown in (b)

below, is a military formula. From letters, it has been extended to longer communications. It is found at times in both typed and printed reports. A third variation, shown in (c) below, contains only the date, a characterization of the subject, and the name of the addressee. Because they are too meager, none of these forms can be recommended for ordinary usage.

(a)

DATE..................
MEMORANDUM FOR MR.......................
FROM MR......................
IN THE MATTER OF............................

(b)

DATE..................

TO ....
FROM.......................
SUBJECT ....

(c)

DATE..................

SUBJECT ....
TO ....

Table of Contents.—The table of contents is an outline of the topics covered in the report. Its function is to give to the reader, who has read the title page, and is therefore acquainted with the subject, an idea of the avenues followed by the writer in developing the theme. The forms which are permissible have been crystallized by usage. They can be explained most easily by reference to a number of characteristic examples.

The first example is from a manuscript report entitled, *A Report on the Financial and Ownership Organization of the Denham Gas Company, Denham, Kentucky.* The spacing and display possibilities of the standard typewriter are effectively illustrated in the mechanical layout of this page. It will be noted that main divisions are separated by double spaces and that subdivisions are single-spaced. Another common practice is that of using capital letters for main divisions and lower-case letters for subdivisions.

(3)

CONTENTS

This outline shows that the text is divided into five main divisions and that three of these—the first, the third, and the fourth—are themselves subdivided. The main divisions are placed one under the other and are demarcated by the use of Roman numerals. The subdivisions are indicated by indentation alone. This arrangement is useful if a writer wishes to emphasize only the essential features of a report.

Sometimes differentiation is carried to three places; that is,

the table of contents is used to indicate the main divisions, the subdivisions, and the sub-subdivisions of the text. This plan is followed in *Practical Experience with Profit Sharing in Industrial Establishments.* The form is exactly the same as that employed in the first illustration. The relative importance of the three divisions is indicated, as before, by indentation and alignment, numeration being limited to the chief headings. Different sizes of type are sometimes employed to accentuate the degrees of subordination.

(4)

CONTENTS

LIST OF TABLES

Again, as in *The Use of an Elbow in a Pipe Line for Determining the Rate of Flow in the Pipe,* University of Illinois Engineering Experiment Station Bulletin 289 (1936), by Wallace M. Lansford, Associate in Theoretical and Applied Mechanics, the main divisions and subdivisions are differentiated not only by indentation and alignment but also by Roman numerals and Arabic figures. An arrangement of this kind facilitates reference to the sections in the text, which may be numbered in the same way.

(5)

CONTENTS

LIST OF FIGURES
[Omitted]

LIST OF TABLES
[Omitted]

A variation favored by many authorities which makes alternate use of letters and figures is capable of extension to at least four places. In the illustration below, from Bulletin 112 (1933) of the Iowa Engineering Experiment Station, *The Supporting Strength of Rigid Pipe Culverts,* by M. G. Spangler, Associate Structural Engineer, numeration of sections and subsections begins over for each main division. As a rule, however, capital letters are reserved for appendices.

(6)

CONTENTS

In many reports, especially brief ones, no numeration is used in the table of contents, indentation alone showing the relationship of the parts. This arrangement is found frequently in reports printed by the United States Government Printing Office.

The only other deviation from the norm that is likely to cause perplexity is the omission of the table of contents in reports where the text is relatively slight. The General Electric Company, for instance, does not require a table of contents unless the discussion extends to at least 10 typed pages. Although there is ordinarily no difficulty in determining, at a glance, the arrangement of material in reports which contain less than two thousand words, there appears to be no reason why the plan should not be indicated in the usual way. A brief outline, proportioned to the length of the text, is of undoubted service.

Exercise: A Table of Contents.—Prepare a table of contents for a report on a subject with which you are already familiar. In it make use of both numeration and indentation. In addition to a mastery of form, this exercise should develop a sense of order and proportion which will be of immediate service.

As an alternative, prepare a table of contents based upon a paper in a technical magazine. The result will, of course, be an analytical outline of the paper.

Letter of Transmittal.—As already indicated, a letter of transmittal, reflecting the conventions of correspondence, usually precedes the text. This letter contains references to the basic purposes of the writer, to the chief phases of the subject, and to the salient aspects of the treatment. Often it mentions the character of the staff and acknowledges assistance received in the preparation of the report.

In the examples which follow, the letter of transmittal assumes two different forms: (1) where responsibility for the text and findings is remote, and (2) where responsibility is immediate.

Letter of Transmittal: Responsibility Remote.—Where a writer is not immediately responsible for the text, the letter is often a mere statement of submission in stereotyped language.

Such a form is ordinarily employed by the heads of government bureaus in forwarding to their administrative chiefs the results of investigations conducted by their assistants. The single sentence of which it consists usually runs: "I have the honor to submit the following report. . . ."

The following letter of transmittal, signed by ex-President Herbert Hoover, from the *Report on the Preservation and Improvement of the Scenic Beauty of the Niagara Falls and Rapids* (Washington, D. C., 1931), illustrates a slightly more informal treatment:

(7)

TO THE SENATE:

I transmit for the information of the Senate in connection with its consideration of the convention between the United States of America and His Majesty the King of Great Britain, Ireland, and the British Dominions beyond the Seas, Emperor of India, for the preservation and improvement of the scenic beauty of the Niagara Falls and Rapids, signed at Ottawa on January 2, 1929 . . . the final report from the Acting Secretary of State and its inclosed copy of a letter from the Secretary of War.

The attention of the Senate is invited to the hope expressed by the Secretary of War that the valuable studies contained in the report may be preserved and made available for future studies by publication as a public document.

(*signed*) HERBERT HOOVER

The White House, April 9, 1930

Where the writer is more immediately responsible, the letter may be extended to include comment on the facts presented. Thus, the Public Printer, in the letter below transmitting a *Report on Condition of Buildings Housing the Government Printing Offices* (Washington, D. C., 1935), emphasizes the conclusions in the report and suggests the need for immediate action:

(8)

TO THE SPEAKER
House of Representatives

For the information of Congress there is submitted herewith a report from the Engineering Department of the Government for

the District of Columbia containing a survey of the old buildings used by the United States Government Printing Office and the elevators now in operation therein.

A brief description of the present plant . . . vividly portrays the inadequate, dangerous, unsanitary, and congested conditions which now exist in the buildings housing this important establishment in the legislative branch of the Government.

Space is at a premium. . . . Hallways and passageways are congested—some of them to such an extent that they have become almost impassible—an intolerable condition created by the grave insufficiency of space.

Every precaution has been taken to the end that employees be protected and not exposed to unnecessary dangers, but no measure of caution which can be devised would be adequate protection against the most serious of all hazards—fire and probably building collapse.

The illustrations with the accompanying engineer's report are offered as substantiation for the immediate need of a new building to house the Government Printing Office.

Respectfully submitted,

(*signed*) A. E. Giegengack

In the letter from the Committee on Smoke Abatement and Electrification of Terminals in Chicago to the President of the Chicago Association of Commerce are references to the nature of the study, to the character of the staff, and to the significance of the result. Compared with the extent and intricacy of the report, with approximately 1,200 large folio pages, 719 illustrations, and 505 tables, it does not diverge greatly from the norm:

(9)

Your Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals in Chicago has the honor of herewith presenting its final report.

Since its appointment . . . your Committee has given close attention to the subject in hand and has had the benefit of the advice and researches of an able staff of experts.

Having had at its command ample resources and the advice and assistance of such expert counsel as it chose to employ, the Committee feels justified in hoping that its report will be of some value

in the solution of a difficult civic problem not only in Chicago but elsewhere.

The Committee has had no difficulty in obtaining the necessary data from the railroads directly interested and is under many obligations to them and to other organizations and individuals in this country and abroad for valuable assistance and advice.

While the Committee's labors have consumed over four years in time, it feels that the importance of the subject matter of the investigation and the effect in our own city, and in other terminal cities, required it to proceed cautiously and to form conclusions only after thorough investigation and careful consideration.

Letter of Transmittal: Responsibility Immediate.—Where the author himself is immediately responsible for the text, letters of transmittal are more significant. In general, they are limited by custom to 2 or 3 pages. Within these limits, however, the treatment may be highly original. Two examples are quoted below:

From the *Report to the President of the Committee on Economic Security* (Washington, D. C., 1935), introducing the principles underlying the National Security legislation of 1935:

(10)

LETTER OF TRANSMITTAL

THE PRESIDENT
The White House

Dear Mr. President:

In your message of June 8, 1935, to the Congress you directed attention to certain fundamental objectives in the great task of reconstruction: an indistinguishable and essential aspect of the immediate task of recovery. You stated, in language that we cannot improve upon:

"Our task of reconstruction does not require the creation of new and strange values. It is rather the finding of the way once more to known, but to some degree forgotten, ideals and values. If the means and details are in some instances new, the objectives are as permanent as human nature.

"Among our objectives I place the security of the men, women, and children of the Nation first.

"This security for the individual and for the family concerns itself primarily with three factors. People want decent homes to live in; they want to locate them where they can engage in productive work; and they want some safeguard against misfortunes which cannot be wholly eliminated in this man-made world of ours."

Subsequent to this message you created, by executive order, this Committee on Economic Security to make recommendations to you on the third of the aspects of security which you outlined,—that of safeguards "against misfortunes which cannot be wholly eliminated in this man-made world of ours."

In the brief time that has intervened, we have sought to analyze the hazards against which special measures of security are necessary, and have tried to bring to bear upon them the world experience with measures designed as safeguards against these hazards. We have analyzed all proposed safeguards of this kind which have received serious consideration in this country. On the basis of all these considerations, we have tried to formulate a program which will represent at least a substantial beginning toward the realization of the objective you presented.

We have had in our employ a small staff, which included some of the outstanding experts in this field. This staff has prepared many valuable studies giving the factual background, summarizing American and foreign experience, presenting actuarial calculations, and making detailed suggestions for legislation and administration. . . . [Here follow four paragraphs acknowledging in detail the assistance received from various groups and advisory committees.] . . .

The responsibility for the recommendations we offer is our own. As was inevitable in view of the wide differences which prevail regarding the best methods of providing protection against the hazards leading to destitution and dependency, we could not accept all of the advice and suggestions offered, but it was distinctly helpful to have all points of view presented and considered.

To all who assisted us or offered suggestions we are deeply grateful.

In this report we briefly sketch the need for additional safeguards against "the major hazards and vicissitudes of life." We also present recommendations for making a beginning in the development of safeguards against these hazards, and with this report submit drafts of bills to give effect to these recommendations. We realize that some of the measures we recommend are experimental

and, like nearly all pioneering legislation, will, in course of time, have to be extended and modified. They represent, however, our best judgment as to the steps which ought to be taken immediately toward the realization of what you termed in your recent message to the Congress, "the ambition of the individual to obtain for him and his a proper security, a reasonable leisure, and a decent living throughout life."

Respectfully submitted,

(*signed*)

FRANCES PERKINS, Secretary of Labor (Chairman)
HENRY MORGENTHAU, JR., Secretary of the Treasury
HOMER CUMMINGS, Attorney General
HENRY A. WALLACE, Secretary of Agriculture
HARRY L. HOPKINS, Federal Emergency Relief Administrator

From John Lyle Harrington and Ernest E. Howard, of Harrington, Howard and Ash, Consulting Engineers, of Kansas City, introducing their *Final Report on the Columbia River Interstate Bridge:*

(11)

The Columbia River Interstate Bridge between Vancouver, Washington, and Portland, Oregon, is completed and in service. We now respectfully submit our final report upon all the principal matters pertaining to its construction. Beginning with our report . . . recommending the adopted location of the bridge and its approaches, we have made many reports to you, including regular weekly reports showing the progress of the work included under each contract, monthly reports and estimates showing the amounts earned by each contractor, reports relating to tests and inspection of materials and workmanship, and various special reports on rights of way, franchises, operation, and similar matters. These are all in your files and available for reference; hence their details will not be repeated. This report will be confined to the more important engineering and business features of the whole project, including your own actions.

The efficient and harmonious working of the Columbia River Interstate Bridge Commission has been largely responsible for the success and celerity with which the work has been carried out. Although composed of the commissions of two counties situated in different states, having different laws and different interests, differing greatly in wealth and population, and contributing different

sums of money, we have found the commissioners, while jealous of the rights, and tenacious of the prerogatives of the community each represented, always fair and reasonable and ready to find some common equable ground for adjusting differences so as to permit the work to go forward. The eminently satisfactory progress and conclusion of the work could not have been attained except for the promptness of the Commission in deciding the many questions presented and for the unwavering firmness with which the Commission adhered to a position adopted or to a policy determined. We have been highly gratified to have the Commission adopt, we believe without exception, our every recommendation.

The care and attention to detail which marked the execution of the design and other technical features are evident in the completed structure and are also indicated in the financial statement. Beginning with an amount of money insufficient, according to early reports, even for a bridge with a 24-foot roadway and one approach on the Oregon side (main bridge $1,660,770; Oregon approach $420,000), the design both of substructure and superstructure proved to be so fitting and economical, and conditions for construction according to these designs so favorable, that the bridge was completed with a 38-foot roadway, with concrete floor, wholly fireproof and with two approaches on the Oregon side, within the funds ($1,790,000), and with a balance of the original fund left with each county (totaling $56,000).

But we have attempted to serve you broadly not alone along technical lines but in the administration and in the general business of buying a bridge and getting full value for the money spent; in the study of the broad and general needs of the public for transportation facilities, which was a large factor in determining the recommendation for the location of the bridge and approaches; in assisting with negotiations for the acquirement of the rights-of-way and other properties; in drafting tentative franchises for street railway operation; in the determination of tolls to be charged; in arranging a scheme of organization for the operating department and in the general problems of administration. We have tried always to give the same careful and detailed attention to every question submitted to us as we have to essentially engineering problems. In this connection, we would like to add that never in a long experience of similar undertakings have we known more sympathetic, broad-minded, and intelligent coöperation from a legal department than you have received, and we have enjoyed, at the hands of Mr. Walter H. Evans, District Attorney, and his associates.

The Columbia River Interstate Bridge is a great public work carried through with intelligence, economy, and efficiency. It should always be a source of gratification and pride to the members of the Columbia River Interstate Bridge Commission; for it cannot but long be known as a monument to their public service.

In the first illustration, where a proposal is under consideration, emphasis falls upon the bases for the proposed recommendations, the character of the staff, and the nature of the recommendations themselves. In the second illustration, from the field of engineering, where an undertaking has been completed, and where the engineers in charge are taking leave of their clients, it falls upon the success of the enterprise. Both letters deal with topics of vital importance.

Often, as in the first letter, a brief synopsis of the text is included. An interesting example, more or less composite in character, is reproduced below.

From C. M. Holland, Chief Engineer, to the New York State Bridge and Tunnel Commission and New Jersey Interstate Bridge and Tunnel Commission:

(12)

In carrying out your instructions to report on a plan, type, and size of tunnel for vehicular traffic under the Hudson River, with a tentative estimate of cost of construction, it was apparent to your Engineer after a survey of the project that the important features are as follows:

I. Location
   1. Limitation by legislation
   2. The territory to be served
   3. Alignment
   4. Approaches
   5. Depth fixed by the United States government
   6. Grades

II. Surveys and Borings

III. Traffic

IV. Capacity

V. TUNNEL SECTION
  1. Headroom
  2. Width of roadway
    (a) Widths of vehicles
    (b) The number of lines of vehicles to be carried
    (c) Safe and convenient operating clearances between vehicles

VI. VENTILATION
  1. The amount and composition of exhaust gases from automobiles
  2. The proper removal of dilution to render the exhaust gases harmless
  3. Method and equipment

VII. TYPE AND METHOD OF CONSTRUCTION
  1. Shield-driven tunnel
  2. Trench tunnel
  3. Caisson tunnel

VIII. ESTIMATES
  1. Construction
  2. Real estate and easements
  3. Operation
  4. Income

IX. It was found necessary, in order to obtain the desired information for a complete analysis of the tunnel project, to make extended investigations. This information is preserved in the form of appendices so that you may be in a position to judge as to the adequacy of the data upon which the conclusions are based.

In accordance with your instructions, all previous reports which have been made in connection with the vehicular tunnel have been carefully examined, and every effort has been made to comply with your desire to arrive at an early decision based on a thorough study of the project, so that the questions which have arisen from every source may be completely answered. From the investigations which have been made and the conferences with the board of consulting engineers, the conclusions reached are submitted herewith.

Exercise: A Letter of Transmittal.—Assume that the text of one of the reports suggested on pages 154-155, 178, 331, or 420 has been

completed and that you are ready to write the letter of transmittal. In writing the letter, bear in mind the relations between writer and reader which ordinarily exist under such circumstances.

Foreword.—In place of the letter of transmittal, reports addressed to the public in general, that is, independent reports, usually contain a brief introductory note known as a foreword. The foreword, or preface, as it is sometimes called, performs substantially the same function as does the letter of transmittal; that is, it establishes contacts with readers and refers to the aim, purpose, and scope of the study, the circumstances out of which it grew, the interest in the subject, and similar matters. Occasional findings and conclusions are also included. Certain foundations, like the Brookings Institution, which issue independent reports use instead of the foreword a general preface signed by the Director. The purpose of such a preface is to indicate the design of the study, the training and experience of the writer, and sometimes the general purposes and objectives of the foundation itself. The illustrations which follow will indicate the general nature of the foreword and show that except in form it differs only slightly from the conventional letter of transmittal.

From *Operating Expenses of Department Stores and Departmentized Specialty Stores in 1928*, Bulletin 78, Bureau of Business Research of the Graduate School of Business Administration of Harvard University (Boston, 1929), in Coöperation with the National Retail Dry Goods Association:

(13)

FOREWORD

This bulletin presents common figures for operating results of department stores and departmentized specialty stores for 1928.

The Bureau has compiled and published the material in the bulletin as part of the general research program which it has been carrying on in the department store field during the past nine years in coöperation with the National Retail Dry Goods Association. The annual publications made possible by this program have been providing department store executives with typical figures for costs, margins, profits, and other operating results with which the

performances of individual stores can be compared. In addition, the bulletins have furnished students with accurate information on the costs of operation in this important field of business, and, also, it is hoped, have aided in creating a better understanding by the general public of the costs of retail distribution.

This bulletin was written by Dr. Charles I. Gragg, Editor of the Harvard Business Reports.[1]

From *The Passenger Car Industry, Report of a Survey* (Philadelphia, 1932), by Charles Coolidge Parlin, Manager, and Fred Bremier, Assistant in the Commercial Research Division, of the Curtis Publishing Company:

(14)

FOREWORD

In 1914, after about a year of field study, we issued a typewritten report on the automobile industry and in the following year printed a summary of the report. The foreword of that report stated: "The report outlines what we believe are the fundamental conditions and the enduring tendencies."

Again in 1931 we made a survey of the automobile industry . . . .

In comparing the conclusions of these two surveys, three facts amaze us:

1. The industry has grown beyond the wildest dreams of 1914.
2. Revolutionary changes in the industry since 1914 have affected profoundly the business, social, and educational fabric of the United States.
3. Many of the tendencies which we found in the survey of 1931 are, to a surprising extent, identical with those in 1914.

. . . we have decided to quote freely from these pages, in the belief that . . . it may prove more interesting and more convincing to reassert these principles in the words used eighteen years ago than to present them in 1932 as new discoveries.

Letter of Submittal.—It frequently happens that a report is prepared by a subordinate who submits it to his chief for

[1] Reprinted by permission of the Bureau of Business Research.

approval before it is finally transmitted to the group or individual who authorized it. Under these circumstances a letter of submittal follows immediately after the letter of transmittal, which is ordinarily formal and stereotyped. As shown by the two illustrations below, one in the field of business and the other in the field of engineering, this letter is usually similar in content and purpose to the letter of transmittal.

From Bureau of Foreign and Domestic Commerce, Department of Commerce:

(15)

Sir:

There is submitted herewith a commercial and economic handbook of Peru prepared by William E. Dunn, American commercial attaché at Lima. . . .

The present volume is the product of a number of years of effort by the Lima Office of the Bureau of Foreign and Domestic Commerce. . . . Some of the basic material was collected by Mr. Carlton Jackson and Mr. Daniel Waters when they were in charge of the office. Later Mr. Dunn visited all the regions of economic importance to gather first-hand knowledge of industrial conditions and business customs. . . .

. . . Numerous persons in business and official life in Peru contributed information in their respective fields of knowledge or duty. The Pan-American Union gave the use of their library and loaned a number of photographs used in the following pages. Practically all of the existing published sources of general and technical data have been utilized.

At present our total trade with Peru amounts to something over $46,000,000 per annum, fairly evenly balanced between imports and exports. Peru has lately seen developments in industry and in constructive public activities that forecast an accelerating progress in the near future. Our capital and technical experience are in fact now coöperating in material developments that are under way. Peru's geographical position and the nature of its industries indicate that contact with the United States will increase steadily. Intelligent plans formed with a clear understanding of the possibilities and limitations, as gathered from the following pages, may improve our present trade position and insure mutually advantageous economic relations in the future.

From the *National Power Survey Interim Report,* Power Series 1 (Washington, D. C., 1935):

(16)

March 15, 1935

To the Federal Power Commission:

Pursuant to the instructions of the Commission and the provisions of the President's Executive Order authorizing the National Power Survey, there is submitted herewith the first of a series of reports on the Nation's power resources and power requirements. . . .

The results and summaries contained in this report, as well as the tentative conclusions, are based largely on an analysis of the returns of 215 electric utility systems, comprising 391 privately owned major operating properties and 21 major municipally owned electric operating systems. . . .

The staff of the National Power Survey takes this opportunity to express its appreciation of the coöperation of the municipal plants and private companies in supplying detailed information concerning their generating plants and transmission systems, characteristics of their load, and other pertinent information; also of the information furnished in published and unpublished form by the Corps of Engineers, United States Army; the United States Geological Survey; the Bureau of Reclamation; the Department of Agriculture; the Bureau of Mines; the Bureau of the Census; and the Federal Emergency Administration of Public Works.

In the conduct of the survey valuable assistance has been received from the regular staff of the Federal Power Commission, particularly its Chief Engineer and Chief Accountant, and from the staff of the Electric Rate Survey, whose field forces assisted in collecting returns from municipalities and companies in the field. Without the coöperation of all of the above, it would not have been possible to present this report.

Respectfully submitted,

(*signed*) Thomas R. Tate,

Director, National Power Survey.

Summary.—The letter of transmittal is often followed by a brief summary of the text and even of the appendix. This summary, sometimes called a "syllabus," an "epitome," a

"summary of report," a "summary report," or an "abstract," completes the process of introduction begun by the title page and continued by the table of contents and the letter of transmittal. The present tendency is to treat it as a synopsis of the material on which it is based. In the more elemental types of report, those devoted to the accumulation and interpretation of fact, the "summary," as it is invariably styled, may extend from 2 or 3 to 20 or even 30 pages. For instance, *A Report on Regulation of Elevation and Discharge of the Great Lakes* (Providence, 1926), by John R. Freeman, contains a "Brief Summary of Studies and Findings" 18 pages long for the 548 pages of text. In the "Summary" of its *Report on Public Utilities, with Forecast to 1930* (New York, 1930), the Blakemore Analytical Reports, Inc. abstracts in 10 pages a text 136 pages long. Similarly, *A Superpower System for the Region between Boston and Washington,* United States Geological Survey Profession Paper 123 (1921), by W. S. Murray and others, begins with a "Summary Report" of 26 pages which includes proportional recapitulations of the various appendices; and the *American Petroleum Industry* (New York, 1935), "a survey of the petroleum industry and its outlook for the future," devotes 22 out of 198 pages to a "Summary and Conclusions."

The function of these synopses, which may be continuous or broken in style, is illustrated with admirable clearness by the "foreword" prefixed to the text of the *Report of the Metropolitan Sewerage Commission of New York:*

(17)

The following report is divided into three sections designated respectively Part 1, Part 2, and Part 3.

Part 1 is a summary of the whole report. It contains a brief statement of the nature and extent of the investigations conducted by the Commission, the principal results of the investigations, and the more important of the Commission's recommendations.

Part 2 is a summary of the investigations. It gives the main facts and results in convenient form for reading and reference.

Part 3 is a classified digest of the data collected during the Commission's investigations.

It has been found impracticable to publish full tabulations of the analyses and observations; these would have occupied several hundred pages. It is believed that the summaries presented in the various chapters of Part 3 will prove sufficient for most purposes; officials who desire to study the observations and analyses in detail may have access to the original data upon request.

The report does not contain a full index. An extensive table of contents, combined with the free use of italic subheads throughout the text, will enable ready reference to be made to the different subjects dealt with in the report.

One result of the demarcation indicated by this passage has been the development of the "double report," as it is generally called, consisting of two distinct parts. The first part, which is usually intended for laymen, is invariably popular in tone; the second, on which it is based, is necessarily technical or statistical in form.

The tendency to include a concise summary of a report in the prefatory pages is well illustrated by two examples, drawn from widely different fields of activity.

From *Tracing Your Wholesale Trade* (New York, 1930), by Walter Mann and Staff:

(18)

This report is divided into five major parts:

Part I A report on a study of the volume and percentage of business done by grocery, drug, hardware, and dry goods jobbers in towns of 10,000 and under.

Part II A report on the opinions of jobbers on small town retailers as a market for these four major types of products.

Part III A picture of the brand preferences for about twenty types of merchandise for each type of wholesaler as indicated by the order of their sales volume. . . .

Part IV A detailed listing of the data supplied by 98 individual wholesalers in the four main channels of trade (grocery, drug, hardware, and dry goods) who collaborated in this study, plus some data on the area serviced by each wholesaler. . . .

Part V (Appendix) Here we have outlined the method in which the interviews were secured as well as complete data on the method of handling the reports statistically.

From the *Report of the Dominican Economic Commission* (Chicago, 1929), by General Charles E. Dawes (Chairman) and a group of well-known authorities:

(19)

NATURE AND CONTENTS OF REPORT

This report is divided into six sections. The first section contains our complete and definite recommendations . . . for the installation of a scientific budget system, including central government accounting, and for an efficient method whereby the government may control its expenditures. This section may be regarded as our specific plan, and the following sections all relate to it. This first section contains:

(a) Proposed changes in the organization of the executive departments of the Dominican Government
(b) A Budget Act
(c) Presidential Decree supplementing Budget Act to be issued by the President after enactment of the law. . . . [Eight other items are listed in this section.]

Section 2. In the second section, although the laws and recommendations we propose in the first section largely explain themselves as they concern the method of their operation, we occupy ourselves with a brief discussion of their principles and their fundamental claims for merit.

Section 3. The third section contains our estimate of the possible economies in appropriations in the Budget of 1929 for executive departments of the Dominican Government for the twelve-month period.

Section 4. In the fourth section we include memoranda by qualified members of the Commission on public works, on municipalities, and on motor transport, and a statement of imports, exports, and trade balances of the Dominican Republic from 1905 to 1928.

Section 5. The fifth section of our report consists of general financial statements of the Dominican Republic reporting (a) the general fund Budget position and (b) the estimated financial condition of that fund as of March 31, 1929.

(a) Budget Statement of General Fund Resources, Obligations, and Balances as of the close of business, March 31, 1929, showing estimated Budget position at end of the calendar year 1929.

(b) General Fund Balance sheet as of the close of business, March 31, 1929.

(c) General Fund Statement of Operations, January 1, 1929, to March 31, 1929.... [Eight other items are listed in this section.].

Section 6. In the sixth section we include a discussion of the present accounting methods and make suggestions for their modification, having in mind that the successful operation of an effective budget system involves a thorough accounting control over all financial transactions.

Appendix. Finally, we are including in an appendix a *pro-forma* budget document consisting only of those sheets which illustrate the set-up of the budget document and several accounting classifications, which are recommended by us in the respective recommendations and laws.

In the more highly specialized types of reports such as those devoted to investigations dealing with the invention of machines or the establishment of theories, the character of the preliminary synopsis styled an "abstract," is entirely different. In such reports, the epitome usually consists of a single paragraph of some length or a series of shorter paragraphs composed of relatively few sentences. As illustrated by the two passages below, the primary function of the abstract is to explain the nature of the study and the significance of the result.

The abstract of *The Production of Liquid Air on a Laboratory Scale,* Bureau of Standards Scientific Paper 419 (1921), by J. W. Cook, Assistant Physicist, is an exposition in miniature of a plant and process for producing liquid air:

(20)

ABSTRACT

The essentials of a plant producing liquid air by the Hampson Process are the compressor, purifying train, and liquefier. The compressor, usually of four stages, delivers air at room temperature and approximately 3,000 pounds per square inch. The com-

pressed air purifying train consists of, first, a trap for receiving oil and water, and, second, suitable containers charged with chemical reagents, such as sodium hydroxide, calcium chloride, or lime, for removing carbon dioxide and water vapor. The air thus compressed and purified is delivered to the liquefier, in which, after passing through a coil of copper tubing, the air is allowed to expand freely to approximately atmospheric pressure. Where this drop in pressure takes place, there is a corresponding drop in the temperature of the air. The expanded air before leaving the liquefier is caused to circulate around the copper coil which contains the compressed air, thus cooling the coil and in turn the compressed air, so that on continuous operation a cycle of progressive cooling is maintained until the temperature ultimately reaches the liquefying point. The liquefier is so constructed that the air which is condensed to liquid is delivered into a receiving vessel. The gaseous air exhausted from the liquefier is returned to the intake of the compressor for succeeding cycles because it has been purified and when used repeatedly will be less exhausting on the purifying reagents.

In length and treatment, this paragraph is typical.

The Abstract of a *Report on the Destruction of Carbohydrates and Organic Acids by Bacteria from a Trickling Filter,* Iowa Engineering Experiment Station Bulletin 110 (1932) follows a well-defined form:

(21)

ABSTRACT

This report deals with the nature and types of bacteria capable of destroying lactic acid, the ability of these bacteria to destroy other organic acids, alcohols, carbohydrates, etc., and some factors which affect the activities of these organisms.

A small building-lath filter, receiving creamery wastes, was employed for isolation of lactic-acid utilizing bacteria. Eighteen species falling into nine genera were thus obtained. Two of the species, *Vibrio circulans* and *Lactobacillus acidovorans,* are considered to be new and are described in detail.

A number of the species are capable of producing organic acids from carbohydrates and oxidizing these acid products, whereas many other species are capable of utilizing the organic acids but do not attack the carbohydrates. These latter organisms are more sensitive to acid reaction than the former.

A reaction of pH 5.0 was found to inhibit a large majority of the species studied and practically all of the carbohydrate non-fermenting acid-destroying organisms. Such inhibiting reactions would occur in the upper part of a trickling filter receiving a creamery waste containing about 0.4 to 0.6 per cent lactose. Occasional doses of high carbohydrate wastes would markedly alter the flora in a trickling filter.

Although acetic acid was readily attacked by 14 of the 18 species studied, its chlorine derivative, chlor-acetic acid, supported moderate growth of only two species. It is suggested that this alteration of availability of acetic acid (by chlorination) for bacterial growth may be of significance in the problem of chlorination of sewage effluents.

Although the subjects of the last two reports are far removed from one another, the epitomes are essentially similar in purpose.

Exercise: An Epitome.—Since the epitome is always prepared after the text of the report has been completed, opportunities for practice under natural conditions are relatively few. As a result, practice must be obtained under conditions which are purely artificial. Prepare, therefore, a summary of an article on some phase of science, industry, or business. Periodicals containing such specialized articles will be found in the average college or public library. This exercise should add to the clearness and conciseness of your style.

Conclusions.—Modern practice in the preparation of reports usually includes with the summary just discussed a section composed of conclusions and recommendations. Sometimes these are placed separately and sometimes together. Their inclusion at the beginning makes reference to them easier. Occasionally they are printed on colored paper, as in *Regulation of Elevation and Discharge of the Great Lakes,* where they occupy 17 out of 19 pages of the section entitled "Brief Summary of Studies and Findings." In this report the conclusions are numbered, sectionalized, and referred to the appropriate pages in the text covering the same topics.

A typical conclusion will serve as illustration:

(22)

(24) A normal low water plane for each lake also is specified, this being placed about 2.5 feet higher than the recent low levels

of Lakes Michigan and Huron, about 2 feet above that for Lake Erie, and about 1.5 feet above that for Superior. (Superior is at present held by means of the regulating gates, at its outlet, at about a foot higher than the level at which it would stand, were there no such artificial control). . . .

The following example is from *Operating Results of Department and Specialty Stores in 1929,* Bulletin 83 of the Bureau of Business Research of the Graduate School of Business Administration of Harvard University (Boston, 1930) by Carl N. Schmalz, Assistant Professor of Marketing and Assistant Director of the Bureau of Business Research:

(23)

9. RETURNS AND ALLOWANCES

There was a general tendency for returns by, and allowances to, customers to be higher in percentage of sales than in 1928. In general, the percentage was highest for the largest stores and varied directly with the sales volume. The range of the typical figures for department stores was from 1.7%, for the stores with sales of less than \$300,000, to 14.0% for the stores with sales of \$10,000,000 or more. A typical percentage could be computed for only one group of specialty stores, those with sales of \$2,000,000 or more. These stores, on the average, had returns and allowances of 16.0% of net sales. The percentage for department stores of similar volume was 10.5%[2].

Text.—The text, which contains the development of the subject with which the report deals, is the heart of the report and, as is to be expected, makes full use of statistics, tables, illustrations, charts, and other devices for presenting facts as concisely and as attractively as possible.

The sections of which it is composed are arranged under headings corresponding with those of the table of contents. As in the table of contents the relative importance of these sections may be indicated by typographical differences and other mechanical devices such as spacing and underscoring. It may also be indicated, to some extent, by independent pagination. Although the text may consist of many parts separated

[2] Reprinted by permission of the Bureau of Business Research.

from one another by distinguishing captions, they all fall into three main divisions comparable to those of the letter:

I. A statement of the purpose
II. A presentation of the theme and supporting data
III. A summary of the result

Within the limits of these divisions it is possible to examine the texts of the various types of report that have been developed to meet special conditions. Of necessity, this chapter is restricted to generalizations that apply to all types; and in this instance, generalizations are naturally few. Fuller analysis of individual types is reserved for later chapters.

Appendix.—Although the function of the text varies with the type of report, the function of the appendix never changes. This unit is a kind of supplement which contains bibliographies and notes, quotations and citations not of immediate significance, theories and formulas, tables and computations, charts and diagrams, and maps and photographs not essential to the development of the subject. As a rule material is placed in the appendices if it is of general interest, if it is of secondary importance, or if it is too bulky to be included in the body of the report. The sections devoted to these matters are differentiated from one another by capitals or Roman numerals, and the headings are listed with those of the text.

Index.—The last unit of the report is the index. With reports that are not extensive or complicated an index is unnecessary. When one is used, the form is sometimes unique. In the ordinary book, the index is a list of references, arranged alphabetically, to important words and phrases and to significant facts and ideas. In the average report, the arrangement is the same. In many reports, however, the index is divided into several sections devoted to specific topics such as the scientists quoted or the readings taken. In a few instances, as illustrated by the following passage from the *Report of the Metropolitan Sewerage Commission of New York,* the index is little more than an extension of the table of contents:

(24)

The report does not contain a full index. An extensive table of contents, combined with the free use of italic subheads throughout the text, will enable ready reference to be made to the different subjects dealt with in the report.

It is doubtful, however, whether a combination of this kind is often justified. Ordinarily the index ought not to diverge greatly from the form which it has assumed in books. As indicated by that prepared for this volume, subheadings may be placed under the main headings, which are often accentuated by larger type.

The index, of course, cannot be prepared until the text has been typed or, if the report is to be printed, until the page proofs are available. As a rule, 3 x 5 cards are employed, one entry only being placed on each card. Each subhead is entered slightly to the right of, and immediately below, a main head, which must appear on every card.

Additional Elements Occasionally Used.—In addition to the elements discussed in this chapter, the writer of a report may occasionally find it necessary to add other conventional units. Among these are:

1. Letters of authorization, acceptance, approval
2. Preface
3. Acknowledgment

Outline of a Typical Report.—In a typical report containing all the elements associated with the form the units fall into three main divisions, according to the following scheme:

I. Prefatory Material
   1. Title Page
   2. Table of Contents
   3. Letter of Transmittal or Foreword
   4. Summary and Conclusions

II. Text

III. Supplementary Material
   1. Appendix
   2. Index

These three divisions vary in significance according to the functions of the type and the interests of the reader. How the first of these factors influences proportion is a subject that must be reserved for future consideration. How the second affects the space devoted to each of the seven units mentioned is also a topic that can be discussed to advantage in succeeding chapters. In general, it may be said, in anticipation, that if the person for whom the report is prepared is an expert, stress will fall upon facts. Because he can analyze them for himself, they may even be presented without comment. On the other hand, if the person addressed is a layman, emphasis will fall upon results, conclusions, and recommendations. In this case, commentaries are more important than statistics. Nevertheless, since the reader may wish to submit the premises to other specialists for verification, they must always be included. One of the most difficult problems, therefore, is to determine what should be placed in the text and what should be placed in the supplement. The preface, which is more definitely governed by custom, is not likely to cause perplexity.

CHAPTER 3

CHARACTERISTICS

Completeness, Clearness, and Conciseness in the Report. —Since the report is a written communication, its characteristics are those of the ordinary business letter. Of the many attributes such as ease and tact that are significant in commercial correspondence, the three C's—completeness, clearness, and conciseness—are recognized as vital. It is an axiom that a letter must deal with nothing less and nothing more than the subject. Similarly, the report, which, like the letter, often deals with corporate matters even though it is addressed to one member of a group with special interests and responsibilities, must be limited to a single topic. Moreover, since the report, like the letter, is occasionally a contract, or at least a record of agreement, there must be no possibility of misunderstanding; and since, like the letter, it is often directed to the type of reader who is exasperated by the superfluous, all unnecessary detail must be eliminated. The essential qualities of the report are, therefore, completeness, clearness, and conciseness. It must be comprehensive; it must be lucid, and it must be as brief as is consistent with its other characteristics.

Accessibility and Emphasis.—To these three qualities must be added two others that grow out of the report as a specialized form of communication: accessibility and emphasis. The report cannot be highly useful if the data which it contains are not arranged for ready reference by means of proper display features. Hence, either the table of contents or the index must be complete, and the material must be made accessible by appropriate subheads and paragraph side headings, by summary and tabulation, and by various graphical devices. The same devices also add emphasis to a report by throwing into relief all essential facts. By due attention to these qualities a

writer can save the time of the reader to the end that the latter may find quickly what he is interested in, get easily what he wants, and be certain that what he has found is *the* important element of the subject. The *Interim Report,* Power Series 7, of the Federal Power Commission, National Power Survey, illustrates these qualities in an effective manner.

Completeness, Clearness, and Conciseness in the Title.—These principles are applicable to all the elements of which the report is composed. This generalization is true even of the title. In his choice, therefore, of a title for a report, a writer must weigh the importance of the three qualities which have been stressed as basic. Since clearness is the most fundamental, the problem usually resolves itself into a decision between the claims of completeness on the one hand and conciseness on the other. A glance at two of the titles cited in this volume—*A Study of Contact Potentials and Photoelectric Properties of Metals in Vacuo; and the Mutual Relation between these Phenomena,* and *Progress Report of a Special Committee Consisting of the Chief Engineer of the Board of Estimate and Apportionment, the Commissioner of Docks, the Commissioner of Plant and Structures, and the Engineer of the Borough of Richmond Concerning the Negotiations with the Trunk Line Railroad Companies with Respect to the Brooklyn-Richmond Freight and Passenger Tunnel Project and the Elements of Difference between the Narrows Tunnel and Port Authority Plans*—will show that completeness is almost invariably triumphant. In other words, the title of a report must be an adequate statement of the subject.

Completeness in the Table of Contents.—Although the same difficulty—the problem of proportion—arises with the letter of transmittal and the epitome, especially in the more elemental types of report, the table of contents is the first serious obstacle encountered by the writer after he has completed the collection of material. Since the illustrations in Chapter 2 have indicated the functions and also the limits of the table of contents, it is unnecessary to do more than recapitulate the facts which have been established. As indicated, it

is really an outline covering the topics of first rate, second-rate, and third-rate importance. It thus touches all the essential features of the report. Although analysis may be extended until every phase is included, this plan would undoubtedly defeat the purpose of the writer. Experience has shown that the average reader is not likely to profit by a table of contents which is carried to more than three places. Like ploughing—and like conversation—the table of contents "should turn up a large surface of life rather than dig mines into geological strata." Completeness is a matter of extent and not of depth.

Clearness in the Table of Contents.—Clearness in the table of contents is secured in two ways: by arrangement and by language; that is, by the form used and the diction employed.

The arrangement of the table of contents is dependent on the text, with which its captions coincide. If the sections in the text are marshalled logically, the headings in the table of contents can be grouped effectively. On the other hand, if the sections in the text lack coherence, the table of contents is certain to be confusing. Where it is possible to organize material according to a definite scheme, relationships may be accentuated by numeration, notation, indentation, and alignment. By these devices, as well as by the use of different kinds of type, the precise degrees of coördination and subordination can be made clear.

Clearness, however, is a matter not only of form but also of diction. The language used in the table of contents is quite as important as the arrangement. Within every series, parallelism is employed, wherever possible, to emphasize equality. In fact, as can be seen by a glance at the illustrations in Chapter 2, the table of contents ordinarily consists of a number of interlocking sections in each of which the headings are related to one another by similarity in the phrasing.

Conciseness in the Table of Contents.—Since the table of contents is exactly what the term implies, conciseness is as important as completeness or clearness. It can be secured by using words for phrases and phrases for sentences. The

process of condensation ought not to be continued, however, until the headings become so general that they are meaningless. Too often, clearness is sacrificed for conciseness.

Completeness in the Text.—The degree of completeness in the text is determined by the training of the reader for whom the report is intended. In all probability, he will belong to one of two distinct groups composed either of technicists or of laymen; that is, composed either of those whose education gives them rank as specialists in commerce, finance, science, engineering, architecture, mining, agriculture, or forestry, or of those, usually executives, whose experience has been restricted to business and industry. Since the problem of adaptation is essentially the same whether a report is addressed to one member or to several members of one of these groups, only the distinction between experts and non-experts is significant. For instance, a report for an expert on an hydroelectric project would be restricted to the data necessary for the determination of a particular policy. For a financier, unacquainted with the technicalities of the subject, it ought to include the more elementary considerations. In every case, the reader's mastery of the subject under discussion governs the choice of material and hence the degree of completeness in the text.

Clearness Secured by Rhetorical Structure.—Clearness in the text, in so far as it is affected by matters of form, depends upon the manner in which the materials are arranged; upon the definiteness with which the sections are connected with one another, and upon the extent to which the units which are similar in function are cast in corresponding molds. Thus a report gains in clearness both in the table of contents and in the text by an organized straightforward sequence of fact.

The order to be adopted must be fixed for each subject. The scheme may be chronological, spatial, or "logical," in the restricted sense of the word; that is, topics may follow one another according to their relationship in time or space or according to their familiarity, interest, or importance. Whatever the nature of the plan adopted, it should always be formu-

lated before the draft of the report is begun. As finally shaped, the outline will be reflected in the arrangement of the text and, therefore, in the table of contents.

Since these sections are related according to a definite plan —chronological, spatial, or logical—transitional expressions and directive devices are less important than in other forms of prose. In the passages cited in this chapter are several paragraphs which point to what has preceded and to what is to follow. Sometimes such signposts consist of a single sentence; sometimes, of two sentences, one of retrospect and one of anticipation; sometimes, of three sentences, the second serving as a link between the first and third. Even more helpful are the finger-boards that merely point to the avenues in the distance. Two of these are reproduced below.

The first is drawn from "A National Plan for American Forestry," *A Report of the Forest Service of the Agricultural Department* (Washington, D. C., 1933). Each section of this report begins with a paragraph or two setting forth the purpose and plan of the section. The following quotation serves as an introduction to the sketch in Volume I entitled "Progress in Forestry." In a few lines the authors indicate the topics to be considered:

(1)

One of the essentials for the formulation of a comprehensive forest policy and plan of land use is an understanding of the wide variation as between different aspects and as between different classes of land ownership. . . .

In the following pages are presented the basic purposes, the progress, and accomplishments, from the standpoint of forestry practices, first, of Federal administrative agencies responsible for national forests . . . and other Federal forest land. These are followed by a review of research in forestry. The treatment of the Forest Service includes particular reference to underlying objectives and to the principles which have been followed in striving to meet these objectives.

Occasionally, as in the *Report on Water Resources of the State of New Jersey and Their Development* (New York, 1922), by Allen Hazen, George C. Whipple, and Weston E.

Fuller, Civil Engineers, the directive characteristics of these finger-boards are more apparent. In this instance, the four developments mentioned suggest as many avenues to be explored. As indicated below, a tabular scheme of this kind is always effective.

(2)

Four principal developments of water for the district have been considered. They may be mentioned in order, beginning with the ones nearest at hand.

1. Complete (or partial) development of the Passaic River.
2. Long Hill Reservoir fed by northern streams.
3. Raritan development, supplemented ultimately, if needed, by water from the Delaware River.
4. Mullica and Wading Rivers and other Southern streams.

We will now present a brief description of these four main possible sources, describing what would be involved in the development of each.

Although it is true that such transitional expressions and directive devices are of less significance in the report than in any other type of literature, and that the captions in the table of contents and the headings in the text are usually sufficient to keep a reader on the right track, there is less possibility of his going astray, and so having to retrace his steps, if he is reminded, from time to time, of what lies before him.

Helpful as these transitions and directions may be, it is doubtful whether they contribute as much to the clearness of the report as do parallel constructions. Nothing is more suggestive than similarity of form where there is similarity of thought. If the items in a series of coördinate units are cast in the same mold, few readers are likely to miss their relationship. The following extracts from (3) *The Narrows Tunnel Plan* and (4) *Smoke Abatement* are arranged in such a way that the reiteration of certain clauses and phrases is like the recurrence of the accented beat in two-four time. The first few words are sufficient to show that another principle or method of disposition is to be introduced.

From *The Narrows Tunnel Plan:*

(3)

The need for radical improvements in our methods of cross-harbor transportation thus having been shown, and authority from the same source having been granted for putting them into effect through separate agencies, it remains to be determined which of them offers the better plan.

In doing this it is self-evident that underlying principles must be adopted as guides to a wise decision for the public good. Among them the ones that are believed to have special force are

1. Fixed charges should be the minimum consistent with the accomplishment of the desired purpose: (a) through avoidance of costly duplicate routes, (b) through utilization of the City's credit for borrowing funds at a low rate of interest, and (c) through the establishment of the route in such manner as to make possible important savings in cost of construction through joint action with other public enterprises.

2. Tonnage to and from Staten Island, Long Island, and New England should be routed around rather than through areas in New Jersey that are now or may in the future become congested by reason of their own local freight and passenger development, as . . . between the Orange Mountain range and the water front.

3. Crossings of rail and water traffic should be separated through the use of tunnels or high level bridges so that one will not interfere with the other.

4. Use of temporary mainline structures should be avoided on account of fire hazard and cost of maintenance.

5. Gradients on steam operated new lines should be at least as light as on the railroads with which they are to connect.

6. The classification of freight cars and their suitable consolidation in trains should be provided for in a modern economically planned clearing yard into which all lines will feed, such yard to be so located as to minimize the territory that necessarily must be electrically operated at the start.

7. The portion of the route to be placed in tunnels should be minimized not only because of their cost but also by reason of the unremunerative non-traffic producing character of the territory so traversed.

8. The route should be so placed as to induce the flow of life-giving traffic where it will do the most good and the least injury to the communities affected.

Having these principles in mind, we may next examine in detail the qualities of the rival plans, that of the City known as the Narrows Tunnel Plan and that proposed by the Port Authority.

From *Smoke Abatement:*

(4)

105.41. CHARACTER OF FUEL AND GASEOUS CONSTITUENTS OF SMOKE:

Solid fuels vary greatly in the amount of sulphur they contain. The quantity of sulphur compounds present in smoke discharges is a function of the amount of sulphur contained in the fuel. In the operation of furnaces, sulphur in the fuel may be disposed of in three ways; namely,

1. By being precipitated through the grate into the ash-pit.
2. By being discharged into the atmosphere through the stack as a solid constituent of smoke.
3. By being discharged into the atmosphere through the stack as a gaseous compound.

Since the facts presented in reports are of such a character that they naturally fall into distinct series, parallel constructions are often employed a number of times in the course of a few pages. Although it may seem that continuous and persistent use of these constructions is likely to be monotonous, the impression produced by the two excerpts above shows that there is no excuse for lack of variety. Reiterative effects may be secured in many ways; and recourse to even a few of them will eliminate the danger connected with their employment.

Clearness Secured by Effective Composition.—Clearness in the text is secured not only by the skeleton of the thought but also by the flesh in which it is clothed. Quite as important as the bones and joints of any outline are the paragraphs and sentences which give them body. From a study of correspondence, it is possible to learn how clearness is obtained through control of these two elements.

In reports, as in letters, paragraphs are relatively simple. They approach the norm of conversation, in which, at its best, a theme is developed by a series of statements amplified by

details and perhaps supplemented by facts. Seldom are they exceptional or unduly complicated. One feature only—the custom of paragraphing separately, as in the extract from *The Narrows Tunnel Plan,* sentences dealing with coördinates—deserves special attention. This device, which originated in the popular newspaper, where it is used for emphasis instead of clearness, is peculiarly striking in summaries and recommendations. Aside from this irregularity, there are no developments that are at all unique.

What has been said regarding the paragraph applies to the sentence. In the report, as in the letter, the sentence is brief, simple, and direct. In its brevity, its simplicity, and its directness, it reflects the norm of conversation. The author who can write as he speaks when he is at his best is not likely to miss the goal.

Clearness Secured by Specialized Vocabulary.—Clearness in the text is dependent also upon the vocabulary selected. To secure the right word is not an easy task. The appeal of a writer is conditioned largely by the definiteness with which he can gauge the equipment of his reader. He must know whether his training has been that of the specialist or that of the man of affairs. Only so far as the diagnosis is accurate will the author be able to adjust his diction to the needs of the moment.

In addressing those who are masters in any field, the writer must use the vocabulary belonging to that field. Every science and every industry possesses a nomenclature which has been sanctioned by usage. Without the aid of the terminology which has been accepted as correct by those who are regarded as authorities, intercourse between experts is impracticable. At first the inclusiveness of these groups of words may seem surprising. For most of the physical and biological sciences there are dictionaries extending, in some instances, to eight or ten volumes. In the fields devoted to particular subjects, the lists are still formidable. *A Glossary of the Mining and Mineral Industry,* Bureau of Mines Bulletin 95 (1920), contains 754 pages, double-columned, of fine print. Although most students will doubtless expect to find that a specialized vocabulary has grown up in connection with a long-established interest like

mining, few of those who have not been associated with the development of the new art of aviation are likely to realize that the *Nomenclature for Aeronautics,* Report 474 (1933), of the National Advisory Committee for Aeronautics, fills 34 quarto pages of fine print. The preservation of wood may not appear to be a process that is likely to contribute materially to the growth of English; but E. F. Hartman, Civil Engineer, and E. F. Paddock, Chemical Engineer, of the Protexal Corporation, devote 27 pages to the *Glossary of Wood Preserving Terms* prepared for the American Railway Association in 1921. A writer who wishes to address his colleagues most clearly and most economically must make himself proficient in the idioms of his particular field. If no printed glossaries are available, it is customary to place at the beginning of the text a series of definitions of special terms. Where a report is intended for a specialist, therefore, clearness is secured by exactness instead of by elaboration; that is, by using terms fixed by convention instead of by using, and afterwards explaining, by means of synonyms, those that appeal to the writer.

There is little excuse for lack of clearness when the reader addressed is familiar with the field in which the subject lies. When he is partly, or entirely, unfamiliar with it, the task of adaptation requires sympathy and insight as well as taste and dexterity. Unless its technicalities are interpreted, the language of a report may appear as strange and unintelligible as the jargon of baseball would seem to a boy from the north of England. The following passage from a dissertation entitled *The Methylation of Para-aminophenol by Means of Formaldehyde,* presented by E. C. Wagner at the University of Pennsylvania in 1921, is an excellent example of a highly specialized vocabulary:

(5)

. . . . These reactions occur strikingly in the case of methylaniline,* the exochlormethyl-derivative of which separates as white needles when the secondary base is allowed to stand with formaldehyde in dilute hydrochloric acid solution. The product, when treated, in solution, with alkali, is transformed into white, amor-

* Goldschmidt, *l. c.*

phous anhydro-p-methylamino-benzylalcohol. Analogous reactions occur also with ethylaniline† and other primary and secondary amines. That anhydroaminobenzylalcohol is a para-compound is shown by its reduction to p-toluidine.‡ The anhydroaminobenzylalcohols are characterized by their insolubility in water and in the usual organic solvents; they are soluble in dilute hydrochloric or other mineral acid, with formation of the corresponding salt. The anhydroalcohols derived from the primary amines are themselves secondary amines, and form nitrosamines. The anhydroaminobenzylalcohols are obtained in a more or less polymerized condition, the degree of polymerization varying with the amount of acid present during their formation.** The simplest member is obtained in the polymerized form from the true alcohol, $NH_2C_6H_4CH_2OH$, by heating with acid,*** as well as by treatment of exochlormethylaniline, $C_6H_5NH.CH_2Cl$, with alkali.

† Goldschmidt, *Chem. Ztg.* 26, 606 (1902).
‡ D. R. P. 83544.
** D. R. P. 96851.
*** D. R. P. 83544.

To the average business man this report, intended for an experienced chemist, would mean nothing at all. Only a writer who remembers the limitations of his reader is likely to be successful. On the other hand, the attempt to secure clearness through exhaustive explanations may easily become ridiculous. It is possible, though rather difficult, to picture a board of financiers in New York entirely unacquainted with the terms used in connection with hydroelectric projects. It is hardly possible to picture a committee of manufacturers in the Niagara Peninsula to whom they are not commonplaces. A report addressed to the first of these two groups might gain in effectiveness through an exposition of the nomenclature adopted. One directed to the second would certainly lose through an explanation of the terms employed. Although the problem of adjustment is by no means simple, it can be solved by knowledge and imagination. Unless it is solved, technical training and experience, however prolonged and extensive, count for little with those whose interests are narrowly executive.

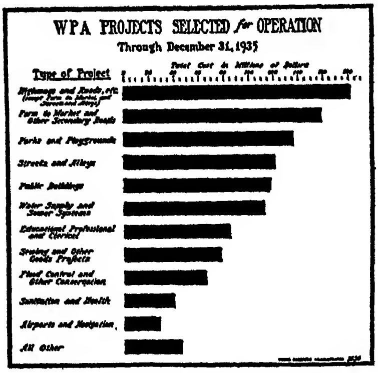
Often, also, a report may be intended for experts who are familiar with the scientific aspects of the subject with which it deals and at the same time for financiers who are seeking opportunities for investment. Clearness in such a situation is

best served by organizing the report in two parts, the first of which is a summary of the findings in non-technical language and the second, a complete presentation of the essential data in technical terms. The private reports issued by large firms of consultants such as the Stone & Webster Engineering Corporation, the Dartnell Corporation, the Business Research Corporation, and Haydon, Stone, and Company are usually so arranged. The *Report of the American Petroleum Institute* (New York, 1925) thus refers, in the introduction, to this practice: "The salient features of each subject are presented briefly . . . , followed by the full texts and the complete data. . . . "

Accessibility in the Text.—Typographical devices such as subdivisional headings, display types, and italics contribute to clearness in the text and also make its material more accessible. For ease of reference, paragraphs are often numbered consecutively, as in the reports of the United States Army engineers. Sometimes items in a series are assigned consecutive numbers, as in the report by Colonel Wilgus, already quoted, or are "tagged" in the same way throughout a report, as in *Smoke Abatement.* In order that the reader may tell at a glance whether he wishes to pursue the subject, paragraph side headings are sometimes used. Thus a well-designed page of a report, whether printed or typewritten, is arranged so as to be easy to read and easy to refer to.

Illustrations, tables, and charts add to the attractiveness of the page and, by breaking it up, make the material easier to follow, as the example on page 66 shows. Careful attention to matters of display, both typographical and illustrative, enables the reader to catch the drift of the argument or presentation in the most expeditious manner. It is a true aid to conciseness.

Conciseness in the Text.—Clearness in the text depends primarily upon prevision; conciseness depends almost entirely upon revision. The plan to be followed in the development of the subject must be fixed before the writing itself can be begun. Even the kind of vocabulary must be selected beforehand.



of the total cost of the program, while sanitation and health projects, housing, electric utilities, and miscellaneous projects, respectively, constitute 3.4, 0.2, 0.2, and 3.7 percent of the total cost. Employment for educational, professional, and clerical persons is to be provided on projects calling for the expenditure of 7.3 percent of the total funds, based on selections for operations through December 31.

Comparison between major classes of projects approved by the President and those selected for operation with respect to the cost in terms of Federal funds can be made by reference to the table below. For only one class of projects, park and playground work, is the percentage of the total selected for operation markedly different from the corresponding project approvals.

Approved W.P.A. Projects and Projects Selected for Operation, by Type of Work

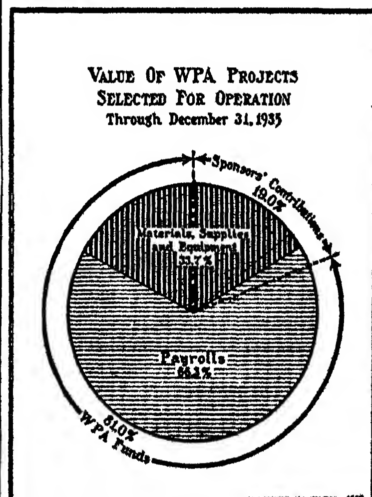
Type of work	Projects approved by the President Jan. 15, 1936		Projects selected for operation Dec. 31, 1935	
	Amount (W. P. A. funds)	Percent of total	Amount (W. P. A. funds)	Percent of total
Grand total	$4,579,269,147	100.0	$947,722,727	100.0
Highways, roads, and streets	1,810,116,845	39.6	362,421,202	38.3
Public buildings, including housing	487,146,923	10.6	89,228,822	9.4
Parks and playgrounds	399,211,378	8.7	118,721,210	12.5
Flood control and other conservation	293,807,134	6.4	55,087,028	5.8
Public utilities	482,443,701	10.5	87,754,490	9.3
Airports and other transportation	152,706,428	3.3	23,888,265	2.5
Educational, professional, and clerical projects	441,927,737	9.7	76,397,446	8.1
Sewing and other goods projects	296,553,584	6.5	68,892,447	7.3
Sanitation and health	124,144,184	2.7	29,094,586	3.1
Miscellaneous	92,289,170	2.0	36,215,234	3.7

A classification of W. P. A. projects based on construction as contrasted with non-construction types reveals that construction projects account for 81.1 percent of the total cost of projects selected for operation through December 31, 1935; non-construction types, including professional and clerical projects, goods projects, forestation, erosion control, improvements to grounds around public buildings, etc., account for the remaining 18.9 percent of the total cost. When construction projects are further subdivided, distinguishing new construction from repairs, modernization, and improvements, it is found that the former represents 36.2 percent of the total cost of all projects and the latter 44.9 percent. These data are presented in the tabulation below.

W.P.A. Construction and Nonconstruction Projects Selected for Operation Through Dec. 31, 1935

Type of work	Number of projects	Total approved cost estimate	
		Amount	Percent of total
Grand total	69,152	$1,169,650,880	100.0
Construction projects	49,085	948,544,645	81.1
New construction	22,384	424,086,908	36.2
Highways, roads, and streets	9,046	135,157,126	11.6
Public buildings	2,109	46,014,608	3.9
Other new construction	10,229	242,895,164	20.7
Repairs, modernization, and improvements	26,661	524,477,752	44.9
Highways, roads, and streets	14,069	326,476,211	27.9
Public buildings	6,399	69,809,500	6.0
Other repairs	6,233	128,192,041	11.0
Non-construction projects [1]	20,067	221,106,235	18.9

[1] Includes forestation and erosion control, educational, professional, and clerical projects, goods projects, health projects, etc.



A Well-Designed Page

(From *Report on the Works Program* (Washington, D. C., 1936), by the Division of Research, Statistics, and Records of the Works Progress Administration.)

Neither the plan nor the character of the vocabulary can be altered afterward without unnecessary labor. Sentences and words, however, can easily be changed. They are like bricks, to be removed, chipped, and fitted at need. Indeed, as Franklin, Stevenson, and others have shown, success in composition is due largely to care in revision. It is no exaggeration to say that after the outlines of a report have been established, and after the main units have been splashed down by the author, who is usually forced to work at white heat under great pressure, a much greater amount of time must be devoted to intelligent and persistent revision. In practice, the average report is cut one-half before it is finally typed.[1]

Some Problems of Style.—Discussion in this chapter has so far been restricted to style in the narrower sense of the term as referring to the mechanics of prose. The word has a larger significance, however, which cannot be overlooked. Milton was fond of asserting that he who wishes to write a great poem must first live one; and, in the final analysis, a work, whatever its nature, is a mere reflection of its author's personality. Although this observation may be especially true of imaginative as distinguished from matter-of-fact literature, it is hardly less true of the latter. About style in this broader aspect—that including approach and treatment—something must be said.

Personality in Approach.—The point of view assumed by a writer is of prime importance in the report.

The logical point of view is always supreme. Neither the individuality of the writer nor that of the reader is ever paramount. Treatment is objective, not subjective. The writer is a mirror reflecting the facts to be projected; the reader, the screen on which they are to be thrown. Although there are instances, as in the reports by Colonel Wilgus and Messrs. Harrington and Howard, in which the position of an author is such that a reference to his professional standing may not seem out of place, these comments are usually restricted to the

[1] Methods of securing a concise style are explained effectively in a government publication, *Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey*, by George McLane Wood. Fourth Edition, revised and enlarged by Bernard H. Lane (Washington, D. C., 1935).

letter of transmittal. Conclusions ought to spring from the premises on which they are based, and recommendations ought to follow almost as matters of course. Whatever the type of report, whether it be a research report, an engineering report, or a marketing report, the facts must speak for themselves. The instances in recent years in which reports using identical data have drawn conclusions in total disagreement are the exceptions that prove the rule. In the letter of transmittal or in the proposals which it contains, every report provides for the expression of personal points of view; but the facts should be presented without prejudice, and the conclusions should be the logical outgrowth of these facts. The text itself is straightforward exposition, not argument or persuasion. Salesmanship has no place in it. If, in the course of his investigations, the writer reaches certain conclusions, he should depend upon the logic of his material to make them evident, not upon the suppression of unfavorable data or the exaggerations of the typical prospectus.

Nevertheless, it is incorrect to assume that the temperament of a writer does not appear in his work. Since the process of reflection indicates the peculiarities of the mirror, certain questions inevitably arise. Is the author devoted to the truth? has he been able to escape from tradition? has he completed his task? The answers to these questions will show what manner of man is writing. They will show whether he is keen of eye, active of mind, and persistent in temper; whether he possesses judgment, alertness, and tenacity; whether, in short, the aspects of his personality are those which inspire confidence.

Personality in Treatment.—What has been said about style in the narrower and also the broader sense of the term may lead to misunderstanding. The report is no rule-of-thumb affair. A writer will find in it scope for whatever skill in language he may possess. He is under no obligation to be dull or monotonous. There are few rhetorical devices which cannot be employed to advantage.

For instance—to consider one of the simplest devices—in *The Columbia River Bridge,* Messrs. Harrington and Howard emphasize by repetition the uniqueness of the structure:

(6)

General Statement

The Columbia River Interstate Bridge is in some respects unique as a public work; unique in the persistence and unanimity of the people of Clarke County and Multnomah County in providing for its construction; unique in the celerity of the public officers in organizing and pushing forward with the work; unique in the rapidity of construction; unique in the fact that the entire work originally contemplated and a complete additional approach were constructed within the money provided; and unique in proving to be a paying investment, with a constantly increasing income. . . .

A passage of this kind brightens the whole page and invests it with an interest that might otherwise be lacking.

Similarly, Colonel Wilgus, in *The Narrows Tunnel Plan,* employs reiteration in summarizing the reasons to be discussed in his report. The cumulative result is most effective.

(7)

In it the attempt is made to show why we are convinced that something must be done to relieve the existing cross-harbor transportation situation, why we feel that the Narrows Tunnel provided for by law offers the best solution of the problem, why we believe that net savings through the use of the Narrows Tunnel route and numerous other advantages to carriers, shippers, and the general public, including better means of military protection in time of war, amply justify the required large expenditure, and why we press upon the railroad representatives the desire of the City to negotiate with them to the end that an agreement may be reached whereby, on equitable terms, this great work may be constructed and jointly operated by them in their interest and in that of the public.

The effective use of statements in climactic series, the selection of strong, simple words, and the faint suggestion of scriptural phraseology make the paragraphs quoted below from *A Report on National Planning* (Washington, D. C., 1934), by the National Resources Board, an excellent example of emphatic, vigorous writing:

(8)

WATER . . . A PROLOGUE

The use and control of water resources present a bewildering array of problems, some technological, some economic, some social, in which, without a guiding principle, it is easy to lose one's way. The vastness of our country, the wide range of climate and topography, the abrupt seasonal changes affecting most of our watersheds, all tend to make the formulation of a national water policy difficult. At the same time they also make it essential. Nothing short of a national policy can deal effectively, justly, and democratically with the situation.

Diverse though the needs and interests are of the different sections, and of different groups in the same sections, they are linked together by a common need and interest. The whole nation is concerned in seeing to it that water shall provide the largest possible amount of beneficial use and do the least possible damage.

There is no stream, no rivulet, not even one of those tiny rills which cause "finger erosion" in the wheat fields of the Corn Belt, that is not a matter of some concern to the people of the United States. The individual and local interest builds up, almost imperceptibly, into the general and national. The individual and the locality profit most in the slow movement of the years, if this larger interest is protected. If one of the deepest of human emotions, the love of parents for their children, is given full play, the whole generation of the living must find satisfaction in making sure that the wealth of the running waters is preserved and enhanced for those who are to come after.

. . . The Golden Rule is no fantastic dream in the use and control of water. It is the only rule that makes good law and good policy.

In the interests of national welfare there must be national control of all running waters of the United States, from the desert trickle that may make an acre or two productive to the rushing flood waters of the Mississippi. . . .

The task of making and carrying out a national water policy will involve many agencies, some existing, some which must be created. It will take a long time. It will demand the highest order of statesmanship and patriotism. We believe that America cannot and must not shrink from the challenge. Here, as in other things that we do and plan, our children's children should have cause to thank us—not to reproach us.

It is obvious, therefore, that the writer of the report has ample opportunity for the display of personality; and that only as he develops it can he hope to realize the possibilities of the form as a medium of expression.

CHAPTER 4

TYPES

Procedure Adopted.—The first three chapters of this volume—those dealing with the origins, elements, and characteristics of the report—together constitute a study of the report as a form in literature. What has been said regarding it in the abstract applies with equal force to the types which have been developed in response to special conditions. The remaining chapters, with the exception of Chapter 20, describe these types at length, with due reference to their distinguishing features. The function of the present chapter, which is anticipatory, and which is necessarily brief, is to summarize the analyses by short definitions which will provide a bird's-eye view of the whole treatment.

Types of Reports.—Although no classification of reports into varieties can be completely logical, and avoid all overlapping, the classification used in this chapter, which is based on well-standardized nomenclature, will serve to identify the principal types. Two factors underlie the classification: (a) the nature of the data and (b) the use made of them. If the data are routine in character, and collected for purposes of record at definite intervals, the report is called an *Information Report;* if the data are not of a routine sort but are especially collected to bear on a special problem, the report is called an *Examination Report;* if the emphasis in the report is not on the data but on what shall be done, the report is called a *Recommendation Report;* and if the data are completely new, constituting a contribution to knowledge, the report is called a *Research Report.*

The Information Report.—The simplest type of report, known as the *information report,* is that prepared by a writer

who is familiar with a set of facts with which the reader is unacquainted. The object of such a report is to record in permanent form data which are constantly accumulating. It assumes two distinct forms, *periodic* and *special.*

Periodic reports, which are invariably administrative, may be either public or private; that is, they may deal with the affairs of a community or of an organization, whether carried on for profit or for purposes other than profit. Thus the citizens of a municipality, the trustees of a school, or the stockholders of a company may wish to know, in due season, what has occurred during a stated period such as a day, a week, a month, or, more generally, a year. Because reports written under such circumstances at regular intervals are matters of course and not of demand, they are styled *periodic.*

On the other hand, an employer or a client may wish to enlarge his knowledge of the projects in which he is interested and may seek enlightenment at any time before they have been begun, while they are under way, or after they have been completed. As already suggested, the *special reports,* whether preliminary, progress, or final, which meet these needs, may be either administrative or professional. Although their purpose is informational, they are not periodic.

Under the head of progress reports also come records of changes in the structure of plants and animals.

The Examination Report.—Closely connected with the information report is the *examination report,* in which a writer presents to an employer or a client certain data, known to others, with which both author and reader are unfamiliar. The purpose of this type is not to establish new truths but to obtain and to interpret the essential facts regarding particular materials, processes, or persons. The investigation leading to the discovery of the facts and the analysis of the data are therefore the distinguishing features. Into this group fall numerous reports in the fields of engineering, business, sociology, and education.

The Recommendation Report.—The data accumulated in an information or an examination report may lead to definite

conclusions which may be submitted to an employer or a client in the form of recommendations. As a rule, a report of this character, which is closely allied with the report which has preceded it, is prepared by an expert who is called in for consultation and advice. The counsel which he may offer is likely to deal either with details of operation or with details of design and construction. As the treatment of these subjects is sharply differentiated, *recommendation reports* are usually subdivided into *operation* and *design* or *construction* reports.

The Research Report.—The three types which have been defined in the preceding paragraphs deal with well-established facts. They are not concerned with the advance of knowledge. The *research report,* on the other hand, is devoted to the discovery of new organisms, the formulation of new theories, and the determination of new characteristics. There are three phases—"descriptive," "theoretical," and "experimental"—with highly specialized techniques. As a rule, the research report is not addressed to individual readers.

Outline of the Types of Reports.—The types of reports may therefore be classified according to the following scheme:

I. Information Reports (Mostly Records)
   1. Periodic
      A. Routine: Daily, Weekly, Monthly (Usually Forms)
      B. Expository and Analytical: Annual, Biennial, Decennial.
   2. Special
      A. Preliminary and Tentative
      B. Progress
      C. Final

II. Examination Reports (Largely Analytical)
   1. Engineering
   2. Administrative and Organizational
   3. Sociological and Educational
   4. Financial and Valuational
   5. Marketing

III. Recommendation Reports (Essentially Argumentative)

1. Operation
2. Design and Construction

IV. Research Reports

1. Descriptive
2. Theoretical
3. Experimental

CHAPTER 5

INFORMATION REPORTS—PERIODIC AND PUBLIC

Source of Information.—The information report follows most closely the scheme outlined in Chapter 2. Of all the types, it is the simplest and the most obvious. The problems connected with it are relatively few. In spite of the fact that its range is unlimited, and that the subjects with which it deals are as wide as the interests of man and as diverse as those of society, the collection of material, which is usually difficult and burdensome, is never onerous. The facts are always at hand. It is the duty of the writer to arrange and to present them in the most effective way. His function is that of a commentator and interpreter.

The sources from which information for reports are drawn are four; namely,

1. Reading
2. Observation
3. Interview
4. Experience

Since the writer of periodic reports has to deal with topics familiar to him, or easily available in his records, he makes use only of the fourth source of information; that is, that amalgam of memory, known as experience, which includes all that a person has read, or seen, or heard, or done. So intricate, however, is the business of life under modern conditions that the average man of affairs finds it necessary to supplement his natural personality by the artificial ego of the card catalog or the account book. The material of an information report consists, therefore, of data which have been accumulated by the writer either in the recesses of his mind or in the files of his office. His task is to present these data as completely, as clearly, and as concisely as possible.

Completeness in the Text.—The chief difficulty which will confront him in performing this task is the necessity of securing completeness. How can he be certain that he has covered all the ground which lies within his province? It must be admitted that he never can be *absolutely* certain. He can, however, be *relatively* certain that his task is done. If he will take pains to enter on separate cards the topics which flash upon him at first thought, and later supplement these by those which will steal upon him unawares, it is improbable that he will overlook any points which are fundamental. By examining some of the thousands of reports which are available and checking against the forms which have been developed in practice, he can also assure himself of the completeness of his own outline.

Clearness in the Text.—Clearness in the text may be obtained by arranging in groups of first-rate, second-rate, and third-rate importance the cards on which the notes have been entered. The headings of the first of these groups will correspond with the primary divisions of the report. The headings of the other groups will correspond with the secondary and tertiary divisions mentioned in Chapter 3. A little practice in shifting cards and in arranging groups will enable even an amateur to formulate a plan that will be logical and clear. With such a plan, there ought to be no possibility of misunderstanding.

Conciseness in the Text.—After an outline like that described in the last paragraph has been drafted, it is well to study the point of view of the reader for whom the report is intended. Is he an expert or a layman? If he is an expert, one phase of the subject may be emphasized. If he is a layman, the theme will be treated excursively, details which are especially intricate being reserved for the appendix, where they may be consulted by the specialists to whom they are submitted for verification. With these two methods of approach in mind, it is advisable to indicate after each topic the number of words which it seems fitting to devote to it. Needless to say, this number ought to correspond with the importance of

the section to which it refers. If the whole report is blocked off in due proportion in this manner, the task of condensation will be lightened materially. At any rate, the outline will throw into relief what is significant and vital.

Kinds of Information Reports.—The information report may be classified in two ways. It may be considered in relation to the interval of time which it covers and also in relation to the group to which it is presented:

I. According to Time
   1. Periodic
      A. a. Daily
         b. Weekly
         c. Monthly
      B. Yearly
   2. Special
      A. Preliminary
      B. Progress
      C. Final

II. According to Group
   1. Public
      A. Municipal
      B. State
      C. National
   2. Private

Although the definition according to group may suggest that the authors of reports are motivated in certain instances by a spirit of service and in certain others by a spirit of gain, there is no distinction of this kind separating the writers of public and private reports. Civilization is a single mechanism which is dependent upon the coöperation of every person who enjoys its benefits. In spite of the fact that it rests upon an economic basis, there is no way of estimating the return which an individual makes to society. Standards of comparison are so intangible that any differentiation from this point of view would be misleading.

Daily, Weekly, and Monthly Reports.—Whether they are public or private, daily, weekly, and monthly reports, which are necessarily administrative, may be quickly dismissed. In long-established industries and businesses, they are invariably "form reports" consisting of questions which have been answered or blanks which have been completed. Although they lie, therefore, outside the limits of this volume as defined in the first chapter, it seems advisable to recur to them before turning to the consideration of yearly reports. Their variety can be illustrated by a few examples. For instance, the daily report required of its salesmen by a large firm manufacturing machinery contains, on a single sheet, blanks for the following data: the name of the salesman and the branch office, and the date and place of writing; the name and address of the customer; a description of the equipment handled; a reference to the original inquiry and the manner in which it was obtained; a statement as to whether an estimate was made, with a note on the price and date of submission; the value of the material which would have to be purchased on the outside; an indication of the way in which the inquiry was followed up; the manner —by call, telephone, or letter—in which it was followed up; the results; a memorandum as to whether the customer required the equipment to be installed; the number of competing firms; the nature of their designs; the reason—high or low prices, prompt or slow delivery, good or bad service, satisfactory or unsatisfactory design—for securing or losing the order; and, finally, a list of the other kinds of equipment manufactured by the company which may be required later on.[1]

Examination of any group of daily form reports will show that in general some or all of the following items are to be found: (a) date and address, (b) names of concern and reporter, (c) number of laborers engaged and sometimes their names and the rates paid, (d) materials used and needed, (e) readings of instruments, tests run, and assignments performed, (f) special remarks. A sample daily report blank will serve to illustrate the ordinary arrangement.

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[1] For a comprehensive analysis see *Salesmen's Reports*, "A Study of the Practices of Leading Companies, in Leading Industries, in the Use of Salesmen's Reports, with Examples of the Forms Used," published by the Policyholders Service Bureau of the Metropolitan Life Insurance Company.

R. J. SMITH COMPANY
INCORPORATED

LABOR FOREMAN'S DAILY REPORT

This Report must be made out in full and turned in to the office every day before leaving the job. No excuse will be accepted for failing to comply with this rule.

JOB

Date____________________193___

	EMPLOYEE'S NUMBER	Excavating Wall Trenches	Excavating Piers	Excavating Basement	Rough Grading	Finish Grading	Ditching for Pipe Line	Laying Pipe Line	Backfilling Ditches					Number of Hours	Rate per Hour	TOTAL AMOUNT		MATERIAL USED AND WORK DONE
1																		Yards Excavated in Trenches
2																		
3																		Yards Excavated in Piers
4																		
5																		Yards Excavated in Basement
6																		
7																		Yards Rough Grading
8																		
9																		Square Yards Fine Grading
10																		
11																		Yards Excavated for Pipe Line
12																		Pipe Laid
13																		Size Inch
14																		
15																		
16																		
17																		Yards Backfilled
18																		
19																		
20																		
21																		
22																		
23																		
24																		
25																		
26																		

Made by__________________ Remarks____________________

Checked by__________________

Entered by__________________

Daily reports of this character naturally become the bases of the weekly reports which today are generally required in industry and business. Certain kinds of information are usually expected. Thus, the weekly report of the Drafting Department of the Port of New York Authority lists the subject, the drawing number, the title, the scale, the percentage of completeness, the medium used, whether ink or pencil, and the names of the draftsman and the superintendent. The weekly report of a corporation specializing in concrete construction calls for data regarding foundations, walls, and floors. In the case of foundations, it calls for specific information regarding date, weather, and temperature; the progress of excavation; and, finally, the number of forms erected and the number of footings concreted. Such weekly reports serve as premises for monthly reports. The monthly report required of the manager of a shop includes such items as the number of machines shipped; the number ready for shipment; the number of orders on hand; the amount of the personnel account; the amount of the operation account; and the amount of the material account, which will, of course, serve as a kind of survey.

Wherever, then, it is necessary to preserve certain types of data, the obvious advantage of having them recorded in identical form leads to the adoption of the form report. In general, it is used in the fields of business and engineering because it offers a convenient and concise method of preserving information which may be required for later reference.

The form reports of the Audit Bureau of Circulation and the Controlled Circulation Audit illustrate admirably the compact presentation of facts regarding the circulation of magazines which may be required by advertisers. They cover varying periods, from a month to a year. An example follows (pp. 82-84).

Like weekly and daily reports, monthly reports, in which statistics for the preceding year are generally included, are useful not only directly, because they meet their own ends, but also indirectly because they lead to the annual reports which are now one of the striking features of business administration. Except that the yearly interval has been fixed by custom as the

AUDIT BUREAU OF CIRCULATIONS

1. COLLIER'S, The National Weekly
2. The Crowell Publishing Company
3. 250 Park Ave., New York, N. Y.
4. Established 1888
5. Published Weekly
6. Statement covers 6 months ending June 30, 1937.
7. Class, Industry or Field Served — The National Weekly.

8. AVERAGES FOR PERIOD:

AVERAGE NET PAID CIRCULATION	
Mail Subscriptions—Individual	1,438,000
Net Single Copy Sales ...(Par. 13)	1,182,261
TOTAL NET PAID excluding Bulk	2,620,261
Term Subscriptions in Bulk	
Single Issue Sales in Bulk	90
TOTAL NET PAID including Bulk	2,620,351

Average Unpaid Distribution

Correspondents, Advertisers & Advertising Agencies	59
Employees, Samples, Exchanges, etc.	18,268
Total Unpaid	18,327

9. NET PAID CIRCULATION INCLUDING BULK BY ISSUES FOR PERIOD STATED IN PARAGRAPH 6:

Date	Copies	Date	Copies	Date	Copies	Date	Copies
Jan. 2	2,505,250	Feb. 20	2,614,855	Apr. 10	2,683,934	May 29	2,591,929
9	2,607,302	27	2,662,091	17	2,666,906	June 5	2,579,528
16	2,580,632	Mar. 6	2,657,678	24	2,635,475	12	2,597,320
23	2,599,595	13	2,655,507	May 1	2,627,400	19	2,585,482
30	2,601,755	20	2,618,204	8	2,613,108	26	2,586,950
Feb. 6	2,643,497	27	2,646,945	15	2,605,724		
13	2,652,673	Apr. 3	2,724,589	22	2,583,029		

10. NET PAID CIRCULATION INCLUDING BULK BY POPULATION GROUPS based on issue of March 6, 1937:
NOTE—Total circulation of this issue was 1.4% greater than the average total circulation for the period.

(For Canada, see reverse side of this page.)

POPULATION GROUP	Mail Subs.	%	Single Copy Sales	%	TOTALS	%
500,000 and over	199,868	14.28	318,505	26.66	518,373	19.98
100,000 to 499,999	289,785	20.70	256,369	21.46	546,154	21.05
25,000 to 99,999	258,129	18.45	203,058	17.00	461,187	17.78
10,000 to 24,999	173,187	12.37	129,129	10.81	302,316	11.65
2,500 to 9,999	219,583	15.69	142,630	11.94	362,213	13.96
1,000 to 2,499	117,460	8.39	66,950	5.60	184,410	7.11
Under 1,000	141,630	10.12	77,844	6.52	219,474	8.46
Unclassified			189	0.01	189	0.01
TOTALS U. S.	1,399,842	100.00	1,194,674	100.00	2,594,316	100.00

11. NET PAID CIRCULATION INCLUDING BULK BY STATES: *(See reverse side of this page)*

12. AUTHORIZED PRICES for sale of this publication during period stated in Paragraph 6:

(a) Basic prices: Single Copy 5c.
Subscriptions 1 yr. $2.00; 2 yrs. $3.50; 3 yrs. $5.00 } 319,818
(b) Prices higher than basic: None }
(c) Combination sales prices: Prices for combination sales of this publication with other publications varied from 60.0% to 96.6% of the combined basic prices of the publications in the combinations. The combination sale prices ranged from $2.15 to $9.00 in actual amounts 156,999
(d) Combination or basic prices: (Publisher unable to identify, also see Par. 16(c)) 15,848
(e) Prices established for sales in quantities: ..... None
(f) Group organizers' prices for this publication alone: ..... None
(g) Association subscription prices: ..... None
(h) Special reduced prices: ..... None

TOTAL SUBSCRIPTIONS SOLD IN PERIOD 491,662
(i) Collection stimulants: ..... None

(Reprinted by permission of the Audit Bureau of

PUBLISHER'S STATEMENT — NOT AUDIT REPORT
MAGAZINE — Period Ending June 30, 1937

[This statement is subject to Annual Audit by the Audit Bureau of Circulations. For Audit Report refer to latest white paper form.]

COLLIER'S, THE NATIONAL WEEKLY

ANALYSIS OF AVERAGE SINGLE COPY SALES
For Period Stated in Paragraph 6.

13. CHANNELS OF SINGLE COPY SALES	Net Sales
(a) Newsdealers	893,817
(b) Boys (1) distribution by organizations other than publisher's own	225,594
(2) distribution by publisher's own organization	62,850
(c) All other channels	None
TOTAL AVERAGE SINGLE COPY SALES	1,182,261

14. BASIS ON WHICH COPIES WERE SOLD TO NEWSDEALERS AND BOYS:

Sold on a fully returnable basis 100%

ANALYSIS OF SUBSCRIPTION SALES (NEW & RENEWAL)
For Period Stated in Paragraph 6.

15. CHANNELS OF SUBSCRIPTION SALES:

(a) Subscriptions direct to publisher	116,954
(b) Catalogue & newspaper subscription agencies, & other publishers	28,375
(c) (1) Publisher's own field selling organization	134,536
(2) Other field selling organizations	158,261
(d) Independent individual subscription salesmen reporting direct to publisher	27,927
(e) Organizers of groups (not combinations) for this magazine	None
(f) Schools, churches, fraternal & other organization workers	27,609
(g) School subscriptions for class use	None
(h) Other channels	None
TOTAL SUBSCRIPTIONS SOLD IN PERIOD	491,662

16. COMBINATION SUBSCRIPTION SALES:

(a) Known combination sales ...(See Par. 12(a))	155,999
(b) Known not to be in combination	319,818
(c) Through intermediaries authorized to sell subscriptions either singly or in combination, therefore unable to determine accurately whether in combination or not	15,845
TOTAL SUBSCRIPTIONS SOLD IN PERIOD	491,662

17. PREMIUMS:
(In sales listed below as subscriptions sold with premiums, the premiums were offered by publisher or with his knowledge.)

(a) Subscriptions sold with premium	None
(b) Subscriptions sold without premium	491,662
TOTAL SUBSCRIPTIONS SOLD IN PERIOD	491,662

18. SUBSCRIPTION SALES BY PRICE CLASSIFICATIONS:
(See Par. 12)

19. DURATION OF SUBSCRIPTIONS SOLD:

(a) For two years or more	269,920
(b) For one year or more but less than two years	217,064
(c) For less than one year	4,678
(d) Subscription salesmen's specials	
(1) For less than one year	None
(2) For one year or more	None
TOTAL SUBSCRIPTIONS SOLD IN PERIOD	491,662

20. TERMS OF PAYMENT:

(a) Paid in advance	164,257
(b) Paid during service	327,405
TOTAL SUBSCRIPTIONS SOLD IN PERIOD	491,662

MISCELLANEOUS CIRCULATION CONDITIONS

21. ARREARS & EXTENSIONS: Average number included in Net Paid (Par. 8) which represents:

(a) (1) Average number of copies served on subscriptions carried in arrears not more than three months	None
(2) Average number of copies served on subscriptions carried in arrears more than three but not more than six months	None

22. RENEWALS OF SUBSCRIPTIONS:
Answer optional and not made.

23. ALL OTHER CHANNELS EXPLAINED: *(Items 2% or more only)*
None

24. THIS PUBLICATION is not an official organ of any association.

25, 26 & 27. *(See Note Par. 28.)*

28. EXPLANATORY:
NOTE—Gaps in paragraph numbers in the form are due to two causes: (1) desirability of retaining familiar paragraph designations regardless of the dropping of obsolete paragraphs as revisions have been made during the course of years; (2) co-ordinating of similar paragraphs in the four types of publishers' forms.

Paragraphs 8 and 9:
It was necessary to estimate the net paid circulation figures for May and June issues in order to file this statement within the time limit.

We hereby make oath & say that all statements set forth in this Statement are true.

JOHN S. BREHM, Circulation Director
A. E. WINGER, Executive Vice-President

Subscribed and Sworn to before me this 29th day of July, 1937.

MARY L. WALKER, Notary Public

My commission expires March 30, 1939.

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Circulations and The Crowell Publishing Company.)

COLLIER'S, THE NATIONAL WEEKLY

11. NET PAID CIRCULATION INCLUDING BULK BY STATES based on the March 6, 1937, issue:

NOTE—Total circulation of this issue was 1.4% greater than the average total circulation for the period.

STATE	Mail Subs.	Single Copy Sales	TOTAL
Maine	12,081	6,343	18,424
New Hampshire	6,527	3,697	10,224
Vermont	5,395	2,495	7,890
Massachusetts	54,361	49,926	104,287
Rhode Island	9,016	5,479	14,495
Connecticut	27,106	18,317	45,423
NEW ENGLAND	114,486	86,257	200,743
New York	122,872	167,932	290,804
New Jersey	45,203	41,846	87,049
Pennsylvania	100,308	85,026	185,334
MIDDLE ATLANTIC	268,383	294,804	563,187
Delaware	3,156	2,383	5,539
Maryland	20,483	10,639	31,122
District of Columbia	10,950	10,308	21,258
Virginia	19,977	13,220	33,197
West Virginia	15,105	13,577	28,682
North Carolina	22,511	12,512	35,023
South Carolina	9,978	5,739	15,717
Georgia	19,936	9,829	29,765
Florida	19,965	30,399	50,364
SOUTH ATLANTIC	142,061	108,606	250,667
Ohio	106,697	67,348	174,045
Indiana	46,120	34,839	80,959
Illinois	81,608	90,241	171,849
Michigan	89,210	53,207	142,417
Wisconsin	35,065	18,201	53,266
EAST NO. CENTRAL	358,700	263,836	622,536
Kentucky	19,710	9,774	29,484
Tennessee	19,749	10,337	30,086
Alabama	17,030	8,145	25,175
Mississippi	9,814	5,897	15,711
EAST SO. CENTRAL	66,303	34,153	100,456
Minnesota	30,322	24,187	54,509
Iowa	35,875	19,521	55,396
Missouri	34,586	24,416	59,002
North Dakota	6,355	5,690	12,045
South Dakota	6,902	5,762	12,754
Nebraska	17,397	11,598	28,995
Kansas	21,794	14,759	36,553
WEST NO. CENTRAL	153,321	105,933	259,254
Arkansas	11,331	7,589	18,920
Louisiana	12,777	10,491	23,268
Oklahoma	19,719	14,605	34,324
Texas	51,824	50,566	102,390
WEST SO CENTRAL	95,651	83,251	178,902
Montana	11,769	9,019	20,788
Idaho	10,293	7,064	17,357
Wyoming	4,918	4,124	9,042
Colorado	19,260	13,223	32,483
New Mexico	4,759	4,933	9,692
Arizona	5,903	8,426	14,329
Utah	6,048	5,659	11,707
Nevada	1,587	2,572	4,159
MOUNTAIN	64,537	55,020	119,557
Washington	31,774	26,599	58,373
Oregon	21,419	16,427	37,837
California	83,016	119,599	202,615
PACIFIC	136,200	162,825	[illegible]
Unclassified		180	180
UNITED STATES	1,380,642	1,184,674	2,564,316
U. S. Territories	2,199	7,622	9,821
Canada	20,186	27,052	47,238
Foreign	2,308	3,033	6,303
Miscellaneous			
GRAND TOTAL	1,424,305	1,233,283	2,657,678

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Par. 11. NET PAID CIRCULATION INCLUDING BULK BY PROVINCES based on the March 6, 1937, issue:

Province	Mail Subs.	Single Copy Sales	Total
Nova Scotia	585	1,077	1,662
Prince Edward Island	54	111	165
New Brunswick	382	815	1,197
Quebec	2,787	4,307	7,094
Ontario	9,343	9,516	18,859
Manitoba	3,496	2,280	5,776
Saskatchewan	807	1,862	2,669
Alberta	978	2,462	3,440
British Columbia	1,733	4,612	6,345
Northwest Territories	6		6
Yukon Territory	15	10	25
Total Canada	20,186	27,052	47,238

Par. 10. NET PAID CIRCULATION BY POPULATION GROUPS FOR CANADA - March 6, 1937, issue:

	Mail Subs.	%	Single Copy Sales	%	Totals	%
500,000 and over	4,646	23.02	3,854	14.25	8,500	17.99
100,000 to 499,999	6,318	31.30	5,813	21.49	12,131	25.68
25,000 to 99,999	1,715	8.50	4,539	16.78	6,254	13.24
10,000 to 24,999	881	4.36	2,775	10.26	3,656	7.74
2,500 to 9,999	3,418	16.93	5,454	20.16	8,872	18.78
1,000 to 2,499	683	3.38	1,490	5.50	2,173	4.60
Under 1,000	2,525	12.51	3,127	11.56	5,652	11.97
TOTALS	20,186	100.00	27,052	100.00	47,238	100.00

(*Reverse*)

time for taking stock of the affairs of a community or an organization, there is no special reason for its adoption. Since it has become the recognized unit, there is, on the other hand, little ground for, or possibility of, a change. The annual report must be considered as an administrative fixture. It therefore deserves serious attention.

Annual Municipal Reports.—Since every one is affected by public reports, and since the principles exemplified by them dominate private reports as well, it seems advisable to begin the study of annual reports with a description of those which are municipal, state, or national in scope. As there are a thousand municipal reports to ten state or national reports, and as the former are consequently of more immediate concern to students and experts, they will be considered first. Moreover, the technique of reports addressed to the public is practically the same, whether the group addressed be large or small, representative of a municipality, a state, or a nation. A brief survey will show that every improvement in the form of such reports has coincided with the growth of interest in the affairs of town or city. In their evolution, municipal reports reflect the development of public opinion and the emergence of civic consciousness. In the days of Tweed and the Philadelphia Gas Ring, local authorities invariably maintained a reserve that was often secretive and sometimes criminal in intent. The only serious reports were those which followed official investigations resulting from occasional outbursts of popular indignation. Today there is no bureau, no department, no division the head of which does not present to his employers, the citizens, an annual statement, containing the essential facts regarding plant, operation, and finance, by which its services may be gauged. Such a review of the year's activities is everywhere regarded as a test of efficiency, as it is a test of honor.

Groups to Whom Municipal Reports Are Addressed.—Municipal reports and similar public annual reports, which are really histories covering a period of twelve months, are addressed, however, not only to the citizens at large, who are employers, but also to two other groups the members of which are themselves employees. Readers may therefore be classified as:

I. Employers in General

Citizens, who will be interested primarily in the affairs of a district or a public enterprise, and who will be attracted by generalizations regarding its progress.

II. Employees in Particular

1. Experts, who will be interested primarily in social, biological, economic, and engineering problems, and who will be attracted by information relating to them.

2. Statisticians, who will be interested primarily in the details of administration, and who will be attracted by financial conditions.

To bear in mind the special interests of these groups and to adapt the material of a report to their individual needs is not an easy problem. It has been solved, however, by the development of a distinct form which enables a writer to address each group in turn.

The content of the average municipal report and the technique of collecting and reporting data have become highly standardized, as indicated by an article (page 303) in *Public Management* (October, 1934):

(1)

Information of the activities and accomplishments of the various departments, together with photographs and comparative charts, is submitted monthly and at the end of the year by department heads to the city manager, who edits the material. In a number of cities the city manager's office compiles material throughout the year for use in the report. . . . [The following data deal with reports from the typical small American city rather than the great municipality.] The average report issued for the year 1933 is 63 pages in length; 6 by 9 inches in size; contains charts, diagrams, and pictures, sets forth accomplishments and recommendations, emphasizes important facts, contains information on the cost of various services; and propaganda material and photographs of officials are conspicuous by their absence.[2]

[2] Reprinted by permission of *Public Management*, official journal of the International City Managers' Association.

In another article (page 51) in the same journal (February, 1933) appear the following directions for the preparation of an annual report:

(2)

Especial attention should be given to the physical make-up of the report with a view of making the cover, title, and general appearance attractive to the reader so as to encourage him to read it. It is suggested that the report be 6 by 9 inches in size, printed on good quality paper in readable type, with the more important facts emphasized by a change of type or by artistic presentation. The report should contain much illustrative material, including diagrams and charts, a few well-chosen maps to indicate certain improvements, and a liberal supply of pictures distributed throughout the report contiguous to the relevant reading material.

An organization chart in the front of the report would help the reader to a clearer understanding of what follows. The report should be opened with a letter which either contains, or is followed by, a summary of outstanding accomplishments and recommendations for the future. The remainder of the material in the report should show a complete picture with each activity occupying space in proportion to its relative importance and arranged in logical order. The accomplishments of the year might be compared with those for previous years, and a comparison of past recommendations with the progress toward their execution would serve as an index of the year's achievements. Data on municipal finances should be presented in a clear and simple manner with a minimum of detailed financial statements. . . . The complete report should not exceed fifty pages in length.[3]

Double Reports.—In the average municipal report, the reports written by the subordinate officials of an administrative unit are arranged coherently by one of their superiors and presented by him, through a letter of transmittal, to those for whom they are prepared. Admirable examples are to be found in the annual reports of the Department of Public Works of

[3] Two other sources of information and help for those preparing municipal reports are the *Report* (New York, 1931) of the National Committee on Municipal Reporting, published by the Municipal Administration Service, 309 East Thirty-Fourth Street, New York City, and the *Basic List of Current Municipal Documents* (New York, 1932), published by the Special Libraries Association, 345 Hudson Street, New York City. This bibliography, which lists all regularly issued reports from some 14 cities of 100,000 or over, important for industrial or geographical reasons, and 45 cities of over 200,000, contains references to over 1,400 documents. It is an invaluable tool for compilers of municipal reports.

the City of Philadelphia, in those of the Chief Engineer of the Board of Estimate and Apportionment of the City of New York, and in those of many institutions, such as hospitals, universities, and museums. By a convenient arrangement, such "consolidated reports," as they are now commonly called, can be easily adapted to the two main groups for whom they are intended. The epitome, described in Chapter 2, has become a popular summary of the data contained in the other sections; that is, municipal reports are often divided into two distinct parts—the first part, which is general in character, being addressed to the citizens at large, and the second part, which is more specific, being addressed to the experts and statisticians who may be interested in it. Because of the success of this innovation, the "double report" has been adopted by many progressive municipalities and other public bodies. In some, for instance, the epitome, which is intended for general circulation, is issued independently. Compared with the old-fashioned annual report, which was entirely technical and statistical, which contained many pages and full illustrations, and which was printed in a limited edition of a few hundred copies, most of which were never opened, it contains few pages and many illustrations; and, unlike its prototype, it finds its way into many homes. It is a symbol of modern democracy, a sign of increased education and intelligence, and a hopeful augury for the future.

Interest in the First Part.—Since public annual reports are always prepared primarily for the citizens at large, the employers of those who write them, it might be assumed that the readers—the people of a community—would always be eager to learn how their affairs have been handled. Usually, however, many are persistently indifferent. In the older communities of the East, only a small minority read the reports for which they pay; and even in the West, where construction work of every kind is being carried on, and where both the householder and the shopkeeper realize more fully their relation to government, it has been necessary to conduct organized "drives" in order to arouse interest and to induce the inhabitants to regard public reports in the same light as they regard the reports

of the companies from which they draw their dividends. The writer of such a report is, therefore, confronted with a difficulty encountered in no other type of report. This fact, already emphasized, influences perceptibly both the method of publication and the character of treatment. Since the daily paper is a medium of communication which assures a maximum number of readers, those charged with the preparation of yearly reports have recently taken advantage of the opportunities which it offers. It is becoming increasingly customary to run the first part of a double report—that is, the epitome, which is a popular summary—in the local journals. It need hardly be said that under such circumstances statistics are omitted wherever practicable, that illustrations are frequently employed, and that other devices to attract and maintain interest are freely introduced. For instance, if a large sum has been spent on a new lighting system, an undertaking with which everyone would be familiar, it might be advisable to begin the review with a reference to it. Nevertheless, in spite of the fact that the arrangement may be informal, the proportions of the first part must coincide with those of the second part; and the epitome must leave a faithful impression of the data which it contains.

Argument in the First Part.—The first part of a double report—that is, the popular summary—is especially useful if the writer wishes to persuade his readers that an undertaking of any kind will be advantageous to them. Although it is true that anything approaching formal argument should be avoided, it may be necessary to tell the taxpayers not only how their money has been spent but also how it ought to be spent. At any rate, since an annual report is a kind of clearing house, suggestions are always in order. Such suggestions, setting forth the essential facts, are often more effective than ponderous briefs. So general have they become that they are now regarded as one of the distinguishing characteristics of municipal reports.

Contrast in the Second Part.—Experts and statisticians are concerned not only with the results of a certain year in a certain organization but also with the results of preceding

years and similar municipalities. Comparisons in time and place are fundamental. In one of his greatest essays, Newman remarks that the power of generalization is the essence of culture. To the expert and the statistician, it is even more. Truth is relative, not absolute. The efficiency with which the social, biological, economic, and engineering bureaus of a city, for instance, are conducted is determined by the standards set in previous years and in other municipalities. In the second part of the double report—that section which contains the reports of the various bureaus—comparisons are therefore essential.

Arrangement in the Second Part.—In this part, the arrangement of material depends upon the character of the bureaus reporting.

In the sections devoted to the work of the social, biological, economic, and engineering departments, there are always two main divisions dealing with the duties which are assigned by law or custom and with those which are purely incidental; that is, with matters of routine or with matters of chance; with definite obligations or with accidental discoveries. The points to be considered are mentioned below:

I. Assigned Functions—the duties fixed by the administration. This section may include descriptions of:
   1. Plant
      A. Equipment: Apparatus
      B. Personnel: Organization
   2. Operation: Procedure and Statistics
      A. Routine operation
      B. Design and construction of new work
      C. Aim and effect upon the life of the community

II. Incidental Functions—the opportunities offered by the conduct of affairs. This section may include comments on:
   1. Improvement of methods
   2. Extension of data
   3. Investigation of phenomena applicable to the needs of the city.

In the sections devoted to the financial departments of the administration, the treatment is entirely statistical. Figures are arranged in tables under appropriate headings; and these tables are extended to other years and to other municipalities in which conditions were, or are, analogous.

Outline of a Typical Municipal Report.—The ideal municipal report, therefore, assumes the following form:

I. PREFACE
  1. Title Page
  2. Table of Contents. A brief outline introducing the reports included.
  3. Letter of Transmittal. A formal statement of submission.

II. TEXT
  1. For General Readers. A popular summary of the data and statistics in the next two sections.
  2. For Special Readers. A series of reports from department heads covering the following subjects:
    A. For Experts. A general description of the plant and its operation.
      (a) Assigned functions
      (b) Incidental functions
    B. For Statisticians. A financial survey.
      (a) Income
      (b) Expenditure

Analyses of typical reports show (*Annual Report of the Westchester County Park Commission,* White Plains, 1932):

1. Report of Commission—36 pages (illustrated)
   Letter of Transmittal
2. Report of Chief Engineer—25 pages (illustrated)
3. Report of County Attorney—3 pages
4. Report of Financial Officers—7 pages
5. Report on Real Estate—4 pages

Annual Report of the Port of New York Authority (New York, 1934):

1. Accountant's Certification—3 pages
2. Letter of Transmittal—4 pages
3. Body of Report
   A. Development and Protection of the Port—11 pages
   B. Construction in Progress—4 pages
   C. Operation of Port Authority Projects—7 pages
   D. General, including financial, real estate, insurance—11 pages
   E. Financial and Statistical Tables—15 pages

Varieties of National Reports.—With the increase in the activities of the federal government has come a vast increase in bureaus, departments, and commissions, each of which is required to summarize its accomplishments in an annual report. As these organizations cover all phases of national life, their annual reports include data ranging from science and engineering to commerce, economics, sociology, and education. These documents are vast repositories of valuable material for the expert. Excellent examples are those issued by the Bureau of the Census, the Bureau of Foreign and Domestic Commerce, the Department of Agriculture, and the National Park Service.

Interest in National Reports.—What has been said regarding the attitude of those for whom municipal reports are intended is also true regarding the attitude of those for whom national reports are prepared. The chief task of the writer is to arouse interest and to secure coöperation. In some of the national departments which have been established within the last decade, much has already been accomplished. Increasingly their bulletins are being influenced by the technique of the special article. They are issued in an attractive form, and they are profusely illustrated with photographs. Excellent examples are the annual reports of the United States Conservation Commission and the National Park Service. In these the pleasantness and value of the open spaces in the commonwealth are set forth with considerable charm. No one can glance at the cuts or the descriptions accompanying them without realizing the importance of the work which is being done and the necessity of extending it. There can be no better argument.

Even more appealing are some of the reports issued by the Canadian Commission of Conservation and the New York State Conservation Commission. These sketches—for they are such in fact if not in name—are sufficient to re-create the joys of a vacation on the Saguenay or an expedition to the foothills of the Adirondacks. It should never be forgotten, however, that the primary function of national reports is not to entertain but to summarize the activities of the bureaus to which they refer. The first problem, therefore, is the presentation of data and the interpretation of statistics, both of which topics are discussed at length in Chapter 7.

Technique in State and National Reports.—In general, the technique of state and national reports does not differ from that of municipal reports. There is, however, one distinguishing feature which should be noticed. As it is customary to indicate the scope of an examination report, so, especially when a report deals with the work of a bureau, department, or division which has just been established, it is customary to indicate its responsibilities by reference to the legislation which authorized its creation. Thus—to borrow an illustration from one of the states—the *First Annual Report of the New York Water Power Commission* (Albany, 1922) contains this paragraph:

(3)

Under the provisions of the Water Power Act, the duties imposed by the Law on the Commission generally refer to and include the following obligations . . . .

Where the boundaries have not been fixed by tradition, a statement of this character is always useful. Indeed, some of the Canadian bureaus include a definition as a matter of course. The necessity for such a definition is set forth clearly in the *Annual Report of the Geological Survey of Canada* (Ottawa, 1902):

(4)

An erroneous impression prevails among many persons who have never had occasion to inform themselves as to the nature of the work performed by this department. . . .

So advisable is it to clarify and to emphasize the functions of a newly established agency that the tendency at present is to include in the annual report both the pertinent legislation and an exposition, somewhat popular in character, of the responsibilities of its personnel. For this reason the *Annual Report of the State Planning Council* (Albany, 1937) quotes "An Act (Chapter 304, Laws of 1935 of the State of New York) . . . creating a division of state planning and . . . prescribing its powers and duties. . . ." These *powers* and *duties* are classified as follows:

(5)

§133. *Powers and duties.* 1. The council shall have the power and it shall be its duty to prepare or coöperate with existing state departments and agencies in the preparation and coördination of plans and policies for the development of the State and for the use and conservation of its resources in so far as such use, conservation or development may be appropriately directed or influenced by state agency.

2. The division may, upon request, furnish advice or reports to any state officer or department on any problem falling within its duties, and may advise the governor on programs for public improvements and the financing thereof. On request of the council any state department or division or agency thereof may be called upon to supply the council with available information and plans in relation to proposed improvement projects or such other matters as it may require in connection with its work.

3. The division shall devise and coöperate with municipal, county, regional and other local planning commissions within the state for the purpose of promoting coördination between the State and local plans and development.

4. The division may confer and coöperate with the executive, legislative or planning authorities of the United States and neighboring states and of the counties and municipalities of such neighboring states, for the purpose of bringing about a coördination between the development of such neighboring states, counties, or municipalities and the development of the State of New York.

5. The division may adopt such measures as may be calculated to promote public interest in an understanding of the problems of state planning, and to that end may publish and distribute copies of any plan or any report and may employ such other means of publicity and education as it may determine.

6. The council shall have such other powers as may be necessary to enable it to carry out its duties under this or any other law and to promote state planning.

In addition the *Report* includes a foreword which deals with the functions of any state planning agency in general and with those of the State Planning Council in particular:

(6)

FOREWORD

In presenting this first report of the State Planning Council, it seems appropriate to quote a brief statement of state planning objectives taken from the report of the former State Planning Board to the Governor, on January 14, 1935.

STATE PLANNING OBJECTIVES

"Theoretically, the scope of state planning is as broad as the purpose for which government itself is instituted, that is, the promotion of the general welfare of the people. Anything that affects the general welfare of the people may, at some time, become an appropriate subject for the application of the planning or policy formulating process.

"Practically, however, the scope of state planning at any particular period will be limited to those physical, social, and governmental sectors in which state-wide developments or changes are taking place, or in which maladjustments are believed to exist. These maladjustments call for a re-appraisal of past policies and methods.

"There are numerous state-wide problems, physical, social, industrial, to which the planning process should be applied: submarginal farm land, forests, surface and underground water supplies, waste disposal, stream pollution, flood control, soil erosion, water power, canals, highways, the preservation of the natural beauty of the countryside, air terminals, town and county boundaries, industrial location, urban expansion, housing, farm electrification, regional markets, public works, wild life and recreation.

"The specific problems which require the application of the planning process will shift from time to time. Changing social and economic conditions will bring demands for readjustments and will present new problems for solution. The planning council should periodically select the three or four problems that are most urgent and from the consideration of which the most valuable results are likely to flow."

State planning is by no means a new concept in the State of New York. It is in fact a regular activity of the major state departments which have to do with the physical development of the State. The present pattern of the State's development gives abundant evidence of the foresight and wisdom with which they have discharged this function.

However, because of the preoccupation of these departments with their own special duties, the needs emerging from other functions may sometimes be overlooked. With a view to preventing such oversight or reducing the number of instances in which this might occur, the State Planning Council as the head of the Division of State Planning has assembled basic information never before brought together in one place. Much of this information consists of material which originated in the several major state departments. The Division of State Planning may be considered as a natural clearing-house through which each of the state departments may keep more closely in touch with the corollary work of the other departments.

In the course of its year's program, the State Planning Council has sought to concentrate on such problems as basic maps, water resources, roadside control and suburban development, but of necessity has been obliged to carry on simultaneously a number of other cooperative studies previously undertaken. These are all discussed briefly in the following report covering primarily the seven month period ending June 30, 1936.

A review of this kind is a valuable means of public education.

Aside from this development, state and national reports do not differ materially from municipal reports.

CHAPTER 6

INFORMATION REPORTS—PERIODIC AND PRIVATE

Significance of Annual Reports in Private Enterprises.—It is difficult to overemphasize the importance of annual reports in private enterprises. Without them corporations could hardly be conducted. Through them—and through them only—can an executive follow the work of the departments and subsidiaries for which he is responsible. In industry and business every official is related to his chief in a kind of pyramidal structure, extending progressively from subordinate to superior. This structure is reflected in the annual report of the manager, superintendent, or president. So efficient is this routine of condensation by which each individual extracts for his head the essence of the reports submitted to him, that not more than one one-thousandth of the data compiled by the members of a railroad staff appears in the final summary prepared for the stockholders. Indeed, most published reports are based upon innumerable private reports which may never be read by more than one person. Without such private reports, no extensive organization can be maintained.

An important source of help in the preparation of annual reports is the series of three reports prepared by the Policyholders Service Bureau of the Metropolitan Life Insurance Company. These studies cover (1) financial statements, (2) charts and exhibits, and (3) descriptive information. Each is based on the examination of a large number of annual reports of representative companies. The studies reveal clearly the increased emphasis on comprehensiveness and attractiveness.

Characteristics of the Annual Report.—The annual report is a kind of history in which bills and battles are replaced—in the report of a railroad, for instance—by tons and mileage,

and in which ideas and arguments are replaced by tables and interpretations. As suggested in the discussion of public reports, the text covers three distinct topics: condition, operation, and result. No matter what the company may be, its annual report will deal with:

A. The property of the company. An inventory.
B. The conduct of the year's business. A history.
C. The effect of this business upon its resources.
D. A financial statement.

The Policyholders Service Bureau of the Metropolitan Life Insurance Company lists five varieties of descriptive information contained in 500 reports of recent years:

1. Names of officers and products, with directory of manufacturing, sales, branch, and affiliated companies.
2. Comment, in addition to balance sheets and profit and loss statements, on the financial condition of the company.
3. New acquisitions, capital expenditures, and changes in corporate structure.
4. An operating review, pointing out salient facts concerning sales and production and sometimes comments on economic conditions and industrial relations.
5. Statistics covering a wide range of topics to show trends and results.

A report dealing with a railroad will treat at length such matters as trackage and rolling stock; one dealing with a power plant will include references to the building and generating units; one dealing with a mine will focus attention upon the machinery and ore in sight; and one dealing with a factory will stress equipment and supplies.

The operation of a railroad will be interpreted in terms of mile tonnage and the number of passengers carried; the operation of a power plant in terms of the coal consumed and the energy generated; the operation of a mine in terms of the area worked and the ore developed; and the operation of a factory in terms of the materials used and the goods produced.

Since corporations are conducted for gain, the result will be expressed in terms of dollars and cents. The statement of

income and expenditure will be supplemented by a statement of assets and liabilities which will include such matters as the value of the company's property and goodwill, the extent of its reserves, and the amount of its stocks, bonds, mortgages, etc. Because data are of little significance unless presented in due perspective, it is customary to use the principles of contrast and comparison in the presentation of statistics. Consequently most annual reports include figures for several years. These contrasts and comparisons make possible a proper interpretation of operations and results. Thus the *Annual Report* (1934) of the American Sugar Refining Company (54 pages, with numerous tables and charts) contains annual profit and loss statements and balance sheets from 1911 to date, in one large folded table, and the *Annual Report* (1936) of the Goodyear Tire and Rubber Company (40 pages, with numerous tables, charts, and photographs) contains, among other data, the facts regarding production since 1902 (see page 101).

President's Report of a Railroad.—The characteristics of annual reports can be illustrated effectively by the report submitted to the stockholders by the president of a railroad. Pressure exerted by public service commissions, the Interstate Commerce Commission, and other federal agencies has led to the development of a standard form, some of the main features of which can be indicated by an outline:

I. CONDITION
- 1. Graphic Description
  - A. Geographical: Territorial
  - B. Profile: Physical
- 2. Literal Description
  - A. Bed
    - (a) Grades: Curves
    - (b) Rails: Ties
    - (c) Bridges: Trestles
  - B. Equipment
    - (a) Cars: Size, Capacity
    - (b) Engines: Weight, Power

II. OPERATION: TRAFFIC

III. Result
  1. A. Income
     B. Expenditure
  2. A. Assets
     B. Liabilities

Examples of annual reports of the leading American railroads, printed each year in the *Railway Age,* show that the features listed in this outline are usually included, although not necessarily in this order.

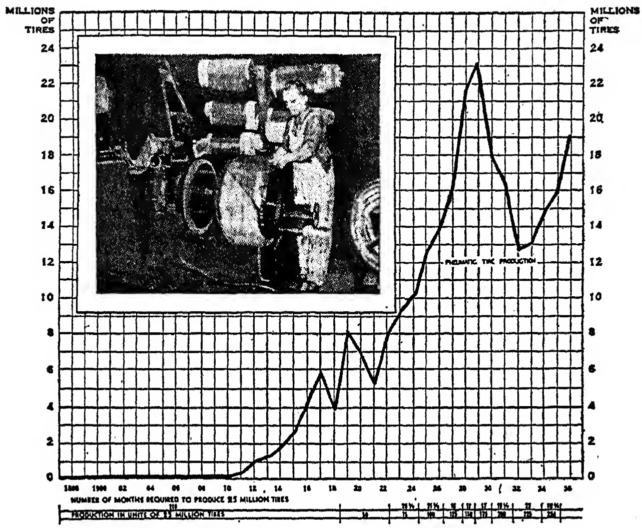
It need hardly be pointed out that such a report is necessarily based upon the reports submitted to the president by the heads of departments.

Engineer's Report of a Railroad.—The engineering department of a railroad is one of the most important. In view of the duties ordinarily assigned to it, what is the character of the information which the president will expect from its chief? Will he not want to know what changes have taken place during the course of the year? Will he not want to know generally about extension and double-tracking; about repairs and replacements, and, more specifically, about grades and curves, rails and ties, and bridges and trestles? In short, will he not want to know about everything within the jurisdiction of the department which will help him to understand the physical condition of the company's property at the end of the twelve months covered by the report? To understand its condition, he will need to be in a position to contrast developments with those of other years and other lines. In every report, studies of this kind are an integral feature.

Annual Reports of Public Utilities.—According to Martin G. Glaeser, in his *Outlines of Public Utilities Economics* (New York, 1927.), annual reports in the field of public utilities have been fixed by legislation since the earliest charters issued to railroads. Because most items are prescribed in detail, uniformity in statistical and accounting practice prevails throughout the United States. "These reports," says Mr. Glaeser,[1] "contain schedules which call for an annual balance sheet, an

[1] Pp. 127 ff.

GOODYEAR PNEUMATIC TIRE PRODUCTION



The chart above and the figures below show the yearly Goodyear output of pneumatic tires for motor vehicles. Behind the modern Goodyear tire is the accumulated experience of manufacturing more than 264,000,000 others over a period of 38 years.

It is of interest to note that 169,607,000 tires, or 64% of the output since inception of the Company, were manufactured within the last ten years.

YEAR	TIRES	YEAR	TIRES	YEAR	TIRES
1902	4,476	1913	1,281,487	1925	12,458,144
1903	7,781	1914	1,788,484	1926	13,781,714
1904	6,666	1915	2,656,588	1927	16,002,630
1905	12,626	1916	4,118,399	1928	21,575,945
1906	23,712	1917	5,880,544	1929	23,073,556
1907	28,307	1918	3,790,212	1930	17,786,814
1908	35,282	1919	8,137,353	1931	16,332,929
1909	94,200	1920	6,863,140	1932	12,635,947
1910	261,888	1921	5,152,503	1933	12,957,612
1911	420,255	1922	7,887,243	1934	14,557,473
1912	1,084,134	1923	9,119,335	1935	15,779,291
		1924	10,056,437	1936	18,904,712
				All-time Goodyear Production	264,557,819

(Reprinted by permission of the Goodyear Tire and Rubber Company.)

income account, and a profit and loss statement. They are supplemented by other schedules calling for further details with respect to particular items. A distinctive feature of annual reports is the schedules calling for statistics of ownership and operation. These statistics are of a miscellaneous character, not readily classified or described. In general terms they relate (a) to units of service, (b) to units of performance, and (c) to units of fixed capital investment. . . ."

As a rule annual reports also contain information regarding the legal history and corporate organization of the utility, its official and operating personnel, the territory served, the number and classification of customers, and the character of the service. All these matters have become important because they aid in making effective a system of regulation which has varied objects and which carries on much of its work at long range.

A typical outline for a public utility, here a holding company, shows the following divisions:

Annual Report of a Public Utility

1. Officers and Addresses
2. Summary of Report
3. Electric Properties
4. Natural Gas Properties
5. New Business Activities
6. Petroleum Properties
    (a) General
    (b) Oil Production
    (c) Oil Pipe Lines
    (d) Refining and Marketing
    (e) Marine Transport
7. Real Estate
8. General
9. Earnings Statement: 20-Year Comparisons
10. Consolidated Balance Sheet
11. Consolidated Income and Surplus Account
12. General Statistics for the Year
13. Capital Statements, Transfer Agents, etc.
14. List of Subsidiary Companies

Superintendent's Report of a Mine.—The report of the superintendent of a mine follows the same general plan. It may be outlined in this manner:

I. CONDITION. DETAILS
   1. Ore
      A. Proved
      B. Prospective
   2. Plant

II. OPERATION. DATA
   1. Tonnage Produced
      A. Cost of Production
      B. Return
   2. Tonnage Estimated
      A. Probable Cost of Production
      B. Probable Return

III. RESULT. STUDIES IN MANAGEMENT

Although the three elements which have been stressed are to be found in a report of this character, the arrangement differs slightly from the norm which has been indicated. The facts of operation and return—two topics which usually occupy distinct places in the report—are ordinarily combined to form a single unit. The third section is then devoted to explanations of the methods employed in the past and to those proposed for the future. Any changes which have contributed, or which may contribute, to the efficiency of the plant and personnel are therefore described in detail. The emphasis placed upon these aspects does not, however, alter the main features of the report.

Manager's Report of a Factory.—If these features are understood, it ought not to be difficult to draft an annual report dealing with any kind of factory. Aside from a few variations which seem to be sanctioned by custom, the report of a manager of a factory coincides closely with that of a manager of a mine. The first section—that containing the descriptive matter—deals with both plant and personnel and contains ref-

erences to the building and equipment as well as to the staff and organization. Although the second section is devoted primarily to the facts of production, it often includes references to efficiency and morale; that is, although it deals theoretically with what has been accomplished, it occasionally covers the manner in which the duties assigned to employees have been performed. While both the first and second sections may be enlarged in the way suggested, the third section is always restricted to financial data. In spite of this restriction, the average report of the manager of a factory is less formal than the other reports which have been cited. Nevertheless, as always, the chief task is to simplify a mass of details and to present them in a form suitable for comparison. In this connection, it should not be forgotten that conditions must be analogous. References to other railroads, other mines, and other factories are of no significance unless circumstances are similar.

Modern Tendencies in Annual Reports.—An examination of the recent files of such magazines as *Printer's Ink, Printer's Ink Monthly,* and *Advertising Arts* indicates a growing interest in the subject of annual reports and an increasing amount of discussion concerning them. For instance, one company discovered that by humanizing its annual report and publishing it in newspaper form it was able to gain materially in interest and effectiveness. According to K. H. Mathus, in *Printer's Ink* (October 12, 1933, pages 12, 13), the typical annual report would be improved by: (1) simplifying the wording, (2) embellishing the report with human interest, (3) supporting it with news items, and (4) illustrating it liberally. Other writers insist upon clear, concise copy, avoidance of the passive voice, and presentation of facts in language which the layman can understand. "Indeed," says A. M. Howe, in *Printer's Ink Monthly* (October, 1934, page 13ff), "The trend toward more complete information was evident before the depression. More and more executives began to realize that, as their stockholder list grew, the need for a different type of report [from the mere financial statement] increased." [2] The present tendency

[2] Reprinted by permission of The Printer's Ink Publications.

is to modernize the stilted language of the old-fashioned report and to explain the data so clearly that the ordinary investor can tell what a company is actually doing.

To aid the writers of annual reports a committee of the Business and Advisory Planning Council for the Department of Commerce has prepared a report entitled, *Reports to Stockholders.* This report points out that "one of the most important problems involved in this question of corporate reporting is that of educating the rank and file of investors to an appreciation of the character of balance sheets and income statements, and especially of their unavoidable limitations." With a few exceptions, annual reports also fail, according to Mr. Howe, in "the presentation of other facts." As an illustration of the sort of information which should be printed, he outlines the section entitled, "Operating Review," from the *Annual Report of E. I. du Pont de Nemours and Company* for 1933. It includes the following items: sales volume, codes of fair competition, chemical and engineering research, patent infringement cases, plant extension and modernization, principal subsidiaries and stockholdings (with chart), foreign investments, relations with employees, stock-investment plan, employee's representation plan, group life insurance plan, salary allotment insurance plan, coöperative sickness and accident insurance plan, pensions, bonus plans, and compensation of the principal executive officers.

Another tendency in private annual reports is to include material of interest to economic, financial, and governmental experts as well as to the public generally. This emphasis on social trends, on human rather than material aspects, is reflected clearly in the scholarly, dignified, and far-reaching summaries which often introduce the statistical sections of many reports of great corporations. The double-report technique enables the responsible officers to avoid a mere statistical résumé and to make use of argument and analysis.

The two following examples from recent reports will illustrate these tendencies.

From the *Annual Report of the American Sugar Refining Company* for 1934:

(1)

The United States Sugar Plan is particularly significant in that it represents a step in the direction of a sound colonial policy under which insular manufacturing industries would be prevented from displacing those long established in this country.

The plan also marks a forward step toward recognizing the obligation of this country to Cuba and to the Cuban *raw* sugar industry. The steadily increasing tariff duties here, and throughout the world, and the never-ending and constantly varying and always futile sugar controls in Cuba, had brought the Cuban sugar industry to the brink of complete ruin.

The new controls under the United States Sugar Plan involve numerous central and local agencies, dealing with far-flung sugar movements over half the face of the globe, which go to make up our national sugar supply. As with all artificial measures, their test will come with the passage of time. As in all such controls, the government necessarily has assumed full responsibility.

Considering the disastrous outcome of the various sugar controls, whose rise and fall we have recorded in these reports for the past twenty years, your Company has good reason to be cautious of all government controls and interferences in the sugar industry. The new United States Sugar Plan, however, is in effect. It is a solid fact. It brings some undoubted benefits for a harassed industry. However, it is capable of doing great injury.

The report from which this extract is quoted contains a large amount of information on the world sugar situation: recent history, legal moves, statistics, tariffs, prices, and even reprints of two statements by experts and a report made by the League of Nations in July, 1934.

From the *Annual Report of the American Telephone and Telegraph Company* for 1934:

(2)

Continuous improvement in telephone service does not just happen. Almost at the beginning of telephone history Alexander Graham Bell and his associates realized that a particular kind of organization was needed for developing interconnecting universal telephone communication in all its possibilities.

The fundamentals of such an organization are:

1. A central administrative coördination and the decentralizing and localizing of operations in regional organizations.
2. Long distance or through truck lines connecting regional operating units.
3. A manufacturing organization to manufacture the intricate and sensitive apparatus.
4. A central bureau for scientific research and for development of technique of operation.

The organization of the Bell System meets these essentials.

It is this form of organization and the interrelation of its parts, in effect in the Bell System for more than fifty years, or since the very beginning of its existence, which makes possible in the United States telephone service that is generally acknowledged to be the best in the world.

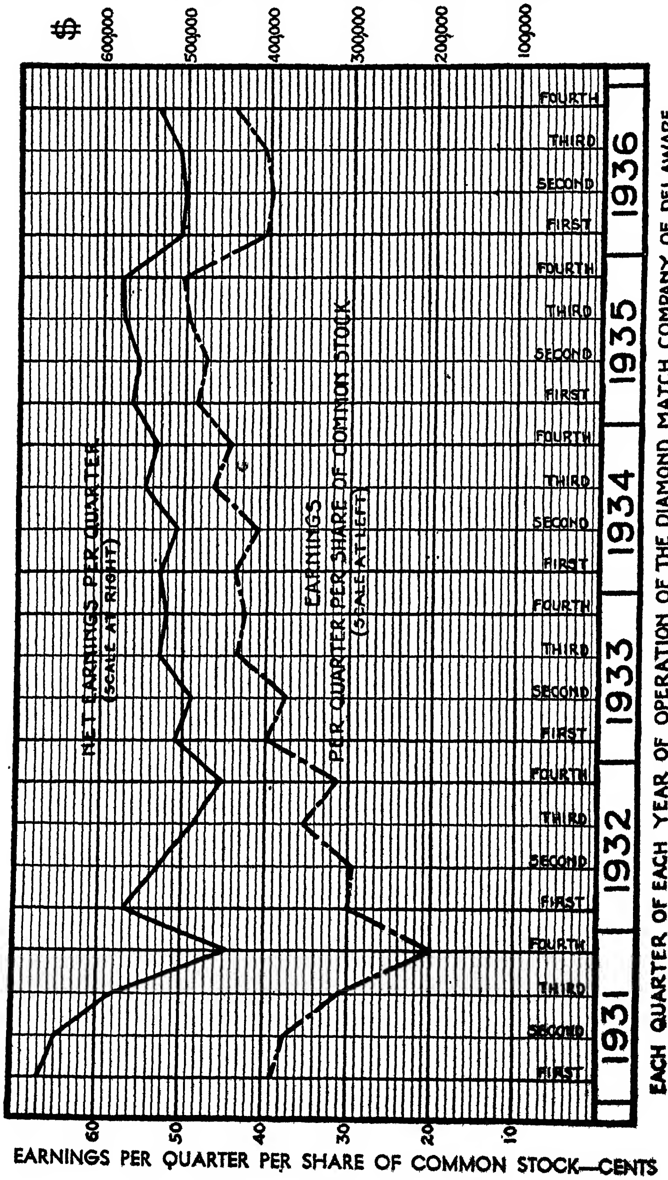
The provision of telephone service for a nation of 125,000,000 people whose individual and collective functioning depends on rapid intercommunication involves the coördination of innumerable details of finance, research, engineering, construction, manufacture, operation, and human relations.

"The message must get through." There is embodied in those words an ideal ever present in the minds of telephone men and women. Fifty-nine million messages a day "got through" in 1934, and service standards were the highest on record. This achievement evidences the skill and enthusiasm of the quarter of a million men and women of the Bell System who are devoted to an essential public service, in which over-all success is so dependent on the efforts of each individual.

Representative Annual Reports.—Although many corporations still cling to the old-fashioned type of annual report, with its meager data and confusing classifications, some corporations, like the American Sugar Refining Company and the American Telephone Company, already cited, have adopted the principles outlined in this chapter and, year by year, have presented to their stockholders adequate summaries and analyses. Among the annual reports of these corporations those issued by the Diamond Match Company are the most comprehensive and the most valuable. Ranging, as they do, over many fields of industry and politics, they are useful to both the economist

APPENDIX "F"

NET EARNINGS PER QUARTER—DOLLARS



and the historian. In the *Report to Stockholders* (1936), the text, extending to 174 pages, is amplified by a "supplement" devoted to photographs, charts, and tables, which is peculiarly effective. It may be consulted to advantage.

The preceding chart, "Appendix F," indicates the character of the devices employed in the interpretation of data for the stockholders and others interested in the status of the Company.

With the annual reports of the Diamond Match Company may be compared those of the General Motors Corporation. Although less detailed, they are no less significant. Indeed, the responsibility of the officers of a corporation and the function of the reports which they are obliged to make have never been defined more admirably than in the introduction to the *Twenty-Eighth Annual Report* (1936):

(3)

MANAGEMENT'S RESPONSIBILITY

The responsibility of the management of an industrial organization to its stockholders has always been fully recognized by the management of General Motors Corporation, and when its operations reach the scope of those of the Corporation, there enters an added and most important responsibility to the community at large. Every effort has been made to discharge adequately both of these obligations. It is felt that this responsibility embraces the obligation of presenting, in detailed form, not only the important facts of a statistical character as to the Corporation's affairs, but in addition such salient matters of a general nature as will enable the stockholders and the public at large to obtain as complete an understanding as is possible of the Corporation's position and of such influences as may affect its trend in the future. . . .

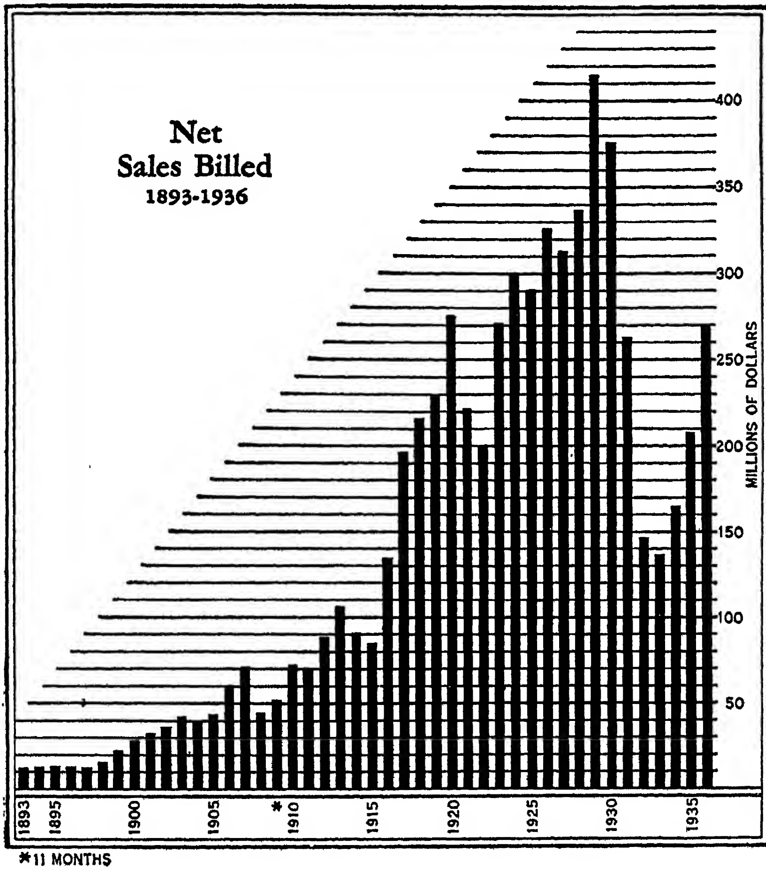
The table of contents will suggest the topics treated.

Especially helpful is the section entitled, "1936 in Brief," which, as the phrase indicates, is a summary of the report as a whole:

1936 IN BRIEF

It is recognized that not all of the Corporation's large body of stockholders will be interested in the detailed presentation and discussion of the financial and statistical facts and circumstances con-

CONTENTS



GENERAL ELECTRIC
COMPANY

tained in the following pages. It must be appreciated, however, that such a full disclosure is essential, not only for those who are interested, but to establish a complete record as well. To accommodate those who may be interested only in the most salient points of the year's operations, the following résumé is presented.

Somewhat slighter are the annual reports of the General Electric Company. It has, however, long followed the practice of including, under appropriate headings, commentaries on all important developments during the year. Like the reports of the General Motors Corporation, its reports are simply but attractively printed and illustrated by occasional graphs. The chart on the back cover of the *Forty-Ninth Annual Report* (1936) portrays dramatically the progress of the company as reflected in the net sales billed during each year of its history.

Another type of report is exemplified by the reports of the Lone Star Cement Corporation (International Cement Corporation). In these the report of the president serves as a summary of the year's operations. As in the *Eighteenth Annual Report* (1936), notes on the items in the consolidated balance sheet are usually included. The "Report of the President" for 1936 is reproduced below:

(4)

REPORT OF THE PRESIDENT

April 20, 1937.

To the Stockholders of
Lone Star Cement Corporation:

The Eighteenth Annual Report of your company is herewith submitted, setting forth results of operations for the year 1936 and the consolidated financial position at December 31, 1936. The consolidated balance sheet and the accompanying consolidated statements of income and surplus, as well as the accounts of the corporation and its domestic and Cuban subsidiaries have been audited by Mėssrs. Loomis, Suffern & Fernald, whose certificate is given herewith. The accounts of the South American subsidiaries have been audited by Messrs. Price, Waterhouse, Peat & Company.

In accordance with the notice sent to the stockholders, a special meeting of stockholders was held on October 15, 1936, at which

meeting the name of the corporation was changed, for commercial reasons, from "International Cement Corporation" to "Lone Star Cement Corporation."

All the domestic operating subsidiaries were completely liquidated as of October 31 and November 30, 1936, and all assets and liabilities were taken over by the Lone Star Cement Corporation on the same basis as they were previously carried on the consolidated balance sheet. Thus your corporation, which heretofore was solely a holding corporation, has become an operating corporation, owning and operating all the plants and properties located in the United States.

Contact with the purchasing public had been for years through subsidiary companies, bearing the name "Lone Star" and selling as their principal product "Lone Star" cement. From the sales angle it was, therefore, considered to the best interests of your corporation to change its name to "Lone Star Cement Corporation."

The consolidated operations of your corporation and its subsidiaries resulted in a consolidated net profit of $2,892,716.71, as compared with $1,048,443.09 in 1935. These profits are after all taxes, charges, etc., which in 1936 included $2,819,219.36 for depreciation and depletion and $342,038.69 for interest on debentures.

The net earnings for the year 1936 as shown by the annual audit exceed the amount shown in the Fourth Quarterly Report by $63,252.61. This change is due principally to a downward adjustment of reserves which were believed to be more than adequate upon the completion of the annual audit.

During the year your company paid five dividends: two quarterly dividends of 37½ cents per share each and two of 50 cents per share each, as well as an extra dividend of 75 cents per share, amounting in the aggregate to $1,947,456.27, or $2.50 per share on the shares outstanding in the hands of the public.

Total additions to plants and properties for the year amounted to $1,283,087.65. The major expenditures were made by the Argentine company in the construction of the new plant at Paraná in the northeastern section of Argentina.

Capital expenditures of $2,933,110 have been authorized for 1937. Of this amount $1,033,110 is planned for additions and improvements to existing plants. The remaining $1,900,000 will be used by the Argentine company to complete the new plant at Paraná. It is planned to have the Paraná plant in operation during October of this year. Plans have been prepared for additional improvements necessary to increase the efficiency of existing plants, appro-

priations for which probably will be requested during the current year.

Holders of $11,572,500 principal amount of the $12,000,000 principal amount of Ten-Year 4% Convertible Debentures (due November 1, 1945) of your corporation exercised during 1936 their option to convert the same into common stock at the rate of $35 per share, there being issued on said conversion a total of 330,257 shares. On January 8, 1937, the remaining $427,500 principal amount of said debentures were called for redemption on February 11, 1937, at 103% of the principal amount thereof and accrued interest, and all of said debentures (except $13,000 principal amount) were converted on or prior to said date into common stock at the rate of $40 per share. Because the holders of certain of said $13,000 of debentures were unable to surrender the same, due to the flood in the Middle West and for other reasons, the time for the conversion thereof was extended to March 11, 1937, and during that period $7,000 principal amount of additional debentures were converted into common stock. The remaining $6,000 principal amount of said debentures which have been called have not yet been presented for conversion or redemption.

The corporation is now free of all funded debt and the total capitalization is represented by 977,770 shares of common stock, of which 10,700 shares are in the corporation's treasury.

The following tabulation shows capacity, capitalization and results of operations for the years 1919 to 1936 inclusive.

The consolidated net current assets of your company at December 31, 1936, amounted to $9,994,324, including $5,622,819 in cash, as compared with net current assets of $6,853,410, including $2,247,228 in cash at December 31, 1935.

A free exchange market existed throughout the year in Argentina, Uruguay, and Brazil, although in Brazil the purchase of free exchange is subject to approval of the exchange control authority. Current assets and current liabilities of the South American subsidiaries are included in United States currency at free market rates at the end of the year, as explained in the balance sheet. Earnings of these subsidiaries are included at the average of the free market rates and are adjusted monthly to reflect the average rates prevailing for each month.

The United States Bureau of Mines reports that the domestic cement industry operated during 1936 at 42.7% of capacity. The demand was unevenly distributed, large tonnages going into work in districts not served by the mills of this corporation. Our

Year	Productive Capacity Barrels	Capitalization: Funded Debt and Notes	Capitalization: Preferred 7% Cumulative	Capitalization: Common No Par Shares	Sales	Total Income	Interest, Federal Taxes, etc.	Net Income	Balance for Common	Earnings per Share Common
1919	2,800,000	$3,649,524	....	238,686	$4,492,624	$743,039	$425,435	$317,604	$317,604	$1.33
1920	3,200,000	2,636,938	....	268,139	8,461,896	2,564,009	784,450	1,779,559	1,779,559	6.62
1921	4,450,000	1,840,801	$1,558,000	323,978	9,172,311	2,271,127	741,226	1,529,901	1,475,374	4.55
1922	4,450,000	1,627,758	1,409,700	324,047	9,407,725	1,862,080	437,033	1,425,047	1,318,031	4.06
1923	5,400,000	345,900	1,468,700	364,167	11,289,117	2,972,430	549,853	2,422,577	2,319,225	6.37
1924	7,000,000	....	3,411,800	400,000	13,683,503	3,771,397	723,890	3,047,507	2,853,917	7.14
1925	12,000,000	....	9,971,700	500,000	17,713,900	4,638,821	662,436	3,976,385	3,518,462	7.03
1926	14,700,000	....	9,694,400	562,500	21,623,582	5,236,220	881,020	4,355,199	3,669,441	6.52
1927	16,200,000	....	9,549,800	562,500	23,671,138	5,420,859	866,687	4,554,172	3,882,983	6.90
1928	20,000,000	18,000,000	....	618,826	27,595,096	6,576,494	1,427,105	5,149,388	4,893,012	7.90
1929	22,000,000	17,995,500	....	627,865	28,370,031	6,620,925	1,670,492	4,950,433	4,950,433	7.88
1930	24,000,000	17,995,500	....	635,798	27,037,855	6,476,067	1,936,557	4,539,509	4,539,509	7.14
1931	24,000,000	17,995,500	....	636,450	20,087,148	2,854,236	1,496,023	1,358,212	1,358,212	2.13
1932	24,000,000	17,995,500	....	636,978	11,108,602	*92,616**	1,343,751	*1,436,367**	*1,436,367**	*2.25**
1933	24,000,000	17,995,500	....	636,978	10,852,081	1,217,685	1,319,951	*102,266**	*102,266**	*.16**
1934	24,000,000	17,995,500	....	636,978	13,648,881	2,331,158	1,664,428	666,730	666,730	1.04
1935	24,000,000	12,000,000	....	636,978	14,085,302	2,591,885	1,543,442	1,048,443	1,048,443	1.64
1936	24,000,000	427,500	....	967,235	18,516,087	4,391,487	1,498,770	2,892,717	2,892,717	2.99

*Loss

domestic mills operated at 38.5% of capacity and our foreign plants at 72% of stated capacity, an average of 48% for all plants.

The increase in construction by private enterprise during 1936 accounted measurably for improved shipments. Construction contracts awarded (37 Eastern States) increased from $1,844,544,900 in 1935 to $2,675,296,000 in 1936. Statistics available, including contracts awarded and construction proposed for all classes of work, indicate an increase for at least the first six months of 1937.

Highway construction showed improvement during 1936. In many states, however, the diversion of gasoline taxes and license fees from public work to unrelated state activities continues. In most of these states large mileage of high type road paving and many new bridges are needed, construction of which would aid greatly in relieving unemployment. . . .

Imports of foreign cement for 1936 were three times those for 1935. The volume of imports is not a large percentage of the total United States consumption, but it is a high percentage of consumption in the coastal markets affected.

In an effort to hold their markets, domestic producers put into effect during the second half of last year reductions in prices ranging from six to sixty-three cents per barrel along the Atlantic and Gulf coasts. . . .

Wage rates and costs of supplies, machinery parts, and fuel advanced during 1936 with further advances in prospect for 1937. These increases naturally affect costs. By means of increased operating efficiency the effect of higher costs will be minimized in an effort to maintain a satisfactory spread between costs and prices realized.

A comparison of wage rates and prices realized for 1936 with those of 1926 shows a wage increase for 1936 of 36%, while prices realized declined approximately 8%.

Operations at five of our domestic plants were conducted throughout the entire year without a lost time accident. It is pleasing to be able to report that the employees appreciate and are cooperating fully with our efforts to eliminate accidents and to safeguard their health.

Research and development activities have been actively continued and the high quality standard of our products and service has been maintained. "Starcor," a new cement for use in deep oil and gas well work, where high temperatures are encountered, has been developed and placed on the market. It has proved very satisfactory and a rapid increase in demand is expected.

We regret exceedingly to record the deaths of one of our directors, Mr. Charles Hayden, on January 8, 1937, and of Mr. J. Eliseo Cartaya, president of our Cuban subsidiary, on December 25, 1936.

In conclusion, I wish to express my sincere appreciation of the splendid co-operation accorded by our stockholders, the able guidance of our directors, and the loyalty and devotion of our employees during the past year.

Respectfully submitted,

(*Signed*) CHARLES L. HOGAN, President.

It is obvious that such an arrangement has many advantages.

Exercise: An Annual Report.—Prepare an annual report on one of the topics listed on page 178. Include tables for several years and employ charts and sketches whenever they will add to the effectiveness of the text.

CHAPTER 7

STATISTICS IN REPORTS

Importance of Statistics.—In the complicated reports of the present day, whether they deal with tons of coal, second-feet of stream-flow, wages, or profits, quantitative data usually furnish the basis for an understanding of the situations presented. Whatever the subject, it is seldom developed without an attempt to measure some of the economic, scientific, or engineering activities of the modern world. To make these data intelligible, writers of reports classify, analyze, and simplify them. As a result, they make constant use of the science of statistics, which has come into being to facilitate such classification, analysis, and simplification.

Classification of Statistical Data.—The first problem in the presentation of statistics is that of classification. Data, to be understood, must be grouped and presented in order upon some established basis. In this way facts can be brought together and understood in the light of their relationships. For instance, a company (American Telephone and Telegraph) may make an analysis (*Annual Report* for 1934) of its earnings into the component parts of preferred dividends, common dividends, reserve, and surplus; or of its plant investment into land and buildings, central office equipment, subscribers' station equipment, pole lines, cable, aerial wire, underground conduit, and all other plant. If these data are presented not for a single year but for each year in a ten-year period, the information will be classified on the basis of time. Further, if the earnings for a given period of time are compared with those of other companies for a like period, the material will be classified on the other important basis, that of space. By means of such classifications, figures can be made to assume a new significance and a new vividness.

Types of Averages in Statistical Studies.—These classifications and comparisons, which are an essential part of every annual report, are greatly aided by the science of statistics. Although it is too large and too intricate a subject to be discussed in detail, and although the treatment in this chapter ought to be supplemented by that in the books mentioned on pages 120 and 522, the principles underlying the use of certain averages—the arithmetical mean, the median, and the mode—are relatively simple.

Of these devices, the only one which is used extensively in administrative reports is the arithmetical mean, in which the items in a series are added and the result is divided by a figure representing the total number. As every one knows, this average is used as a basis of comparison where—as when the annual profit or loss of several cycles is at issue—the contrast extends over a considerable period. Because it is possible to give, in this way, an adequate idea of a large number of units which have certain characteristics in common but which differ in other respects, the arithmetical mean is peculiarly effective.

In the simplest types of administrative reports, the median is obtained by arranging a series according to size, weight, capacity, and so forth—that is, by preparing a table of frequencies—and selecting as representative the number which indicates the middle measure. In scientific studies, where care is necessary, it is obtained by determining mathematically the curve which fits the data most closely and then integrating to a point giving half the total area. Often, it is less useful than the arithmetical mean. Nevertheless, where the extremes do not differ widely, and where distinction between two series alone is important, it is of great value. In many reports, references to the height of a river or to the temperature of a district at certain times are fundamental. Although the arithmetical mean is generally employed in such studies, the median, especially if there has been a flood or a period of excessive heat, will probably be required to supplement it. Indeed, if there are a few striking variations which will affect materially the nature of the arithmetical mean, the median may reflect conditions more accurately.

As popularly employed, the mode is the term applied to the typical members of a series or to the unit of a group which occurs most often. In scientific studies, it is the value of the class with the greatest frequency. Like the median, it is often less reliable than the arithmetical mean. Nevertheless, like the median, it sometimes produces a surprisingly true picture of conditions. When derived simply from an inspection of the table of frequencies, it is, however, often misleading. Like the median, it should be determined mathematically by fitting a curve to the data.

The advantages and disadvantages of each of these three devices are described more fully by R. A. Fisher in a book full of practical material, *Statistical Methods for Research Workers* (London and Edinburgh, revised and enlarged, 1936). Bruce D. Mudgett's *Statistical Tables and Graphs* (Boston, 1930) contains elementary instructions for the preparation of tables and graphs, and R. E. Chaddock's *Principles and Methods of Statistics* (Boston, 1925) is a comprehensive treatment, including pertinent illustrations and a useful bibliography.

Uses of Statistics.—The uses of statistics are not limited to contrast. In all, they are employed in yearly reports in four ways: in history, in description, in comparison, and in prediction. Since annual reports are always retrospective, they generally include summaries of the records preserved in earlier reports. The three devices mentioned—the arithmetical mean, the median, and the mode—may therefore be utilized to indicate progress or retrocession, success or failure. Moreover, a statistical abstract is often the most illuminating method of interpreting present conditions. Every one is familiar with the application of this method to stock, order, and shipping accounts. As already pointed out, these accounts can easily be contrasted with those of preceding years. Through these contrasts, tendencies can be established and projected into the future. Just as, in surveying, it is possible to run a line by one already fixed, so it is possible to anticipate, by the methods described above, the course of a train of events which has already begun. The element of prediction in annual reports is rapidly becoming one of the most notable and serviceable features.

Having calculated averages, if these are pertinent, and having determined a purpose and a method of classification, a writer is ready to present his statistics to the reader. Three ways are open to him. He may present them in running exposition, *literally;* he may present them in a list, with like data in columns, *tabularly;* he may present them in some form of picture, curve, or sketch, *graphically;* or he may combine any or all of these methods.

Tabular Presentation.—Professor Raymond Pearl in his volume, *Medical Biometry and Statistics* (London, 1923), states that "the purpose of tabulation is so to arrange observations that the like cases shall be put together and their frequency of occurrence in the whole group thus be made apparent." Therefore the first step in proper tabulation is to make certain that the items bear an immediate and apparent relation; that is, that they are part of a *classification* on an accepted *basis,* which reflects the purpose behind the tabulation. Next, they must be arranged concisely and intelligibly. In its simplest form, a statistical table is therefore composed of two columns, the first usually consisting of related but independent items such as years or names of cities and the second a quantity, dependent on the first, such as rain-fall, food-prices, or population. The principle may be extended to a multiple tabulation in which the left-hand column designates an item or period to be studied and the successive columns to the right denote various facts about the item or period.

The obvious advantages of a statistical table are its simplicity and conciseness. Since each item is differentiated from the other items, data can be easily found and readily referred to.

Other requirements of a statistical table may be summarized as follows:

1. All units in a table should be described in terms of definitely recognized standards such as feet, dollars, or tons.
2. Each column should be separated by a line or a wide space from the other columns.
3. Each column should bear an appropriate and unambiguous heading indicating its function.

4. Each table should bear a title which gives a clear, concise, and complete description of the material assembled in it.
5. "Each table," says F. C. Mills, in *Statistical Methods* (New York, 1924), "should constitute a unit, self-sufficient, and self-explanatory. All explanations necessary for its interpretation should be included as integral parts of the table or in the form of footnotes."
6. Tables should be numbered consecutively throughout a report.
7. In typed manuscripts tables should be "framed" as well as columns; that is, each table should be enclosed with lines.
8. Where possible, variable quantities should be arranged in a scale, increasing from left to right and from top to bottom.

Examples of well-designed and properly labeled tables appear on pages 149 and 152.

Illustrations of the ways in which tabular arrangements may be employed will be found in the reports of the United States Census Bureau and the United States Bureau of Statistics.

Graphical Interpretation of Statistics.—Valuable as tabular arrangements may be, they are often surpassed in effectiveness by those which are distinctly graphic. The purpose of a table and the purpose of a graph, however, are not exactly the same. The function of a graph is to present a picture which can be understood at a glance; the function of a table is to supply the data from which a picture may be prepared. The first is for visualization, the second for reference. Many tables are primary, containing crude data which may be utilized in various ways. Other tables are derivative, containing data refined for specific ends. Nevertheless, although these tables may be separated from their bases by several steps, they may always be checked against them.

Statistics may, however, be presented even more vividly and simply to the reader by graphical representation. "Exhibits simplify and clarify the facts contained in the annual report to

stockholders. They are time and effort savers. Exhibits give the stockholder an intimate picture of a company's products, plants, operations, purposes, and positions" begins a pamphlet entitled, *Charts and Exhibits in Annual Reports to Stockholders,* prepared by the Policyholders Service Bureau of the Metropolitan Life Insurance Company. The pamphlet points out that charts and diagrams may be used successfully to present graphically (1) the financial history of a company, (2) the underlying economic situation, (3) the extent of operations, and (4) the corporate structure, affiliations, internal organization, manufacturing processes, and use of products.

Concise rules for the preparation of charts have been formulated by the Joint Committee on Standards for Graphic Presentation and widely printed in manuals of statistics.[1] In substance these rules call for simplicity, accuracy, and uniformity. Since a chart appeals to the eye, and since its meaning is determined visually, it is well to remember that the eye judges distances and that it is aided by angles, ratios, color, and shading. Hence these devices become the tools of the chart-maker. He should therefore avoid too much detail on his charts and too radical a departure from the conventions which have been established.

Two main classes of graphs are commonly employed in reports:

1. Charts: Measuring by means of curves the amounts of frequencies of quantitative or temporal variables and showing a relationship between two or more variables.
2. Sketches: Measuring frequencies, trends, and distribution in space of a group of independent variables and also certain conventional non-mathematical relationships.

Charts.—As the following sections show, charts assume many forms; but common to all is the curve or line connecting points representing the data to be measured.

Curves.—The simplest form of chart is a curve drawn to rectangular coördinates, the y-axis or ordinate for the vertical line and the x-axis or abscissa for the horizontal. More complex forms need not be considered here. It is customary to

[1] Copies may be secured from the American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York City.

use the abscissa for the independent variable; that is, the one which increases by increments arbitrarily determined, as time elements, and to use the ordinate for the dependent variable. Therefore, a line connecting the points will give to the reader a continuous picture of conditions presented by the data. Although it is customary to draw a straight line between the points plotted on the chart, sometimes, especially in presenting engineering data, the line is smoothed out so as to assume a curve touching the points as nearly as possible. Where two or more curves are plotted on one chart, care should be taken to distinguish them by a clearly explained code. It is well, however, not to place too many curves on one sheet. Moreover, since the slope of the curve is what the eye notes, curves should be so chosen as to give an honest picture of conditions. The art of preparing graphs is explained fully in numerous books such as William C. Marshall's *Graphic Methods* (New York, 1921) or any standard textbook in engineering drawing. Illustrations of well-designed simple curves occur at several points in this book, notably, the curve of earnings of the Diamond Match Company on page 108, and the population curves on pages 151 and 153.

BAND CHARTS.—A specialized form of chart called the band chart may be used where it is desired to break down a total figure into its component parts; as, for instance, world consumption of sugar, with bands in various shadings indicating the percentage produced by each country. An excellent example from the *Annual Report* of the American Sugar Refining Company is shown in Figure 1.

RATIO CHARTS—In some reports it is important to emphasize the rate rather than the amount of growth represented. A chart of this kind is plotted on semi-logarithmic or ratio paper; that is, the ordinates are laid to a logarithmic scale and the abscissæ to an arithmetic scale. A curve, like the right-hand chart in Figure 2, which is plotted on ratio paper, indicates by a change in the slope the rate of change, a condition not so easily ascertained from the left-hand figure, which shows the same data plotted on an arithmetic scale. Ratio charts are useful to show population trends or rates of growth of a business.

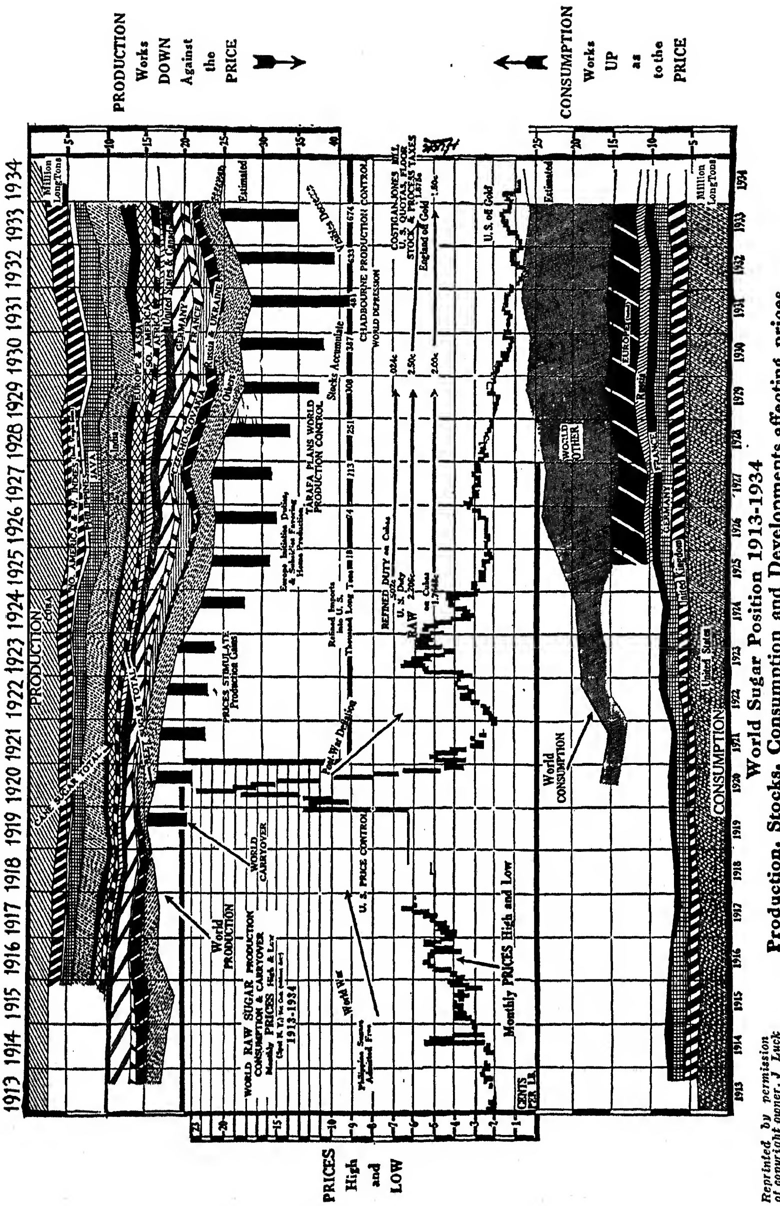


Figure 1. A Band Chart
(From *Annual Report*, 1934, American Sugar Refining Company, p. 55)

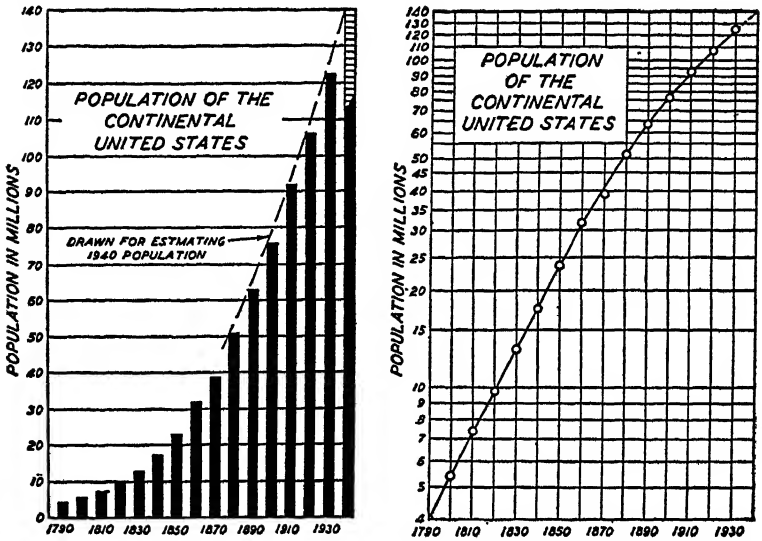


Figure 2. A Simple Ratio Chart Compared with an Arithmetic Chart Using the Same Data

(Reprinted by permission from H. H. Jordan and R. P. Hoelscher, *Engineering Drawing*, 3rd Ed., published by John Wiley & Sons, Inc., 1935, p. 341)

FREQUENCY CURVES.—Another form of statistical chart used in reports is the frequency polygon or histogram, which reproduces graphically the data on averages already discussed. If a smooth curve is fitted to the data, it is called a frequency curve. If such a curve is unsymmetrical, the mode and the mean lie furthest apart, with the median one-third of the distance from the mean toward the mode. In preparing tables from which frequency curves are to be constructed, it is important to choose class intervals small enough to represent the facts fairly. An illustration will show how such tables are constructed, how the various averages are determined, and how the data are plotted on the curve. Figure 3A shows the ungrouped data, Figure 3B a method for grouping data into classes after the interval (here, 3 degrees of temperature) has been chosen, Figure 3C the computations for determining the mean, and Figure 3D a frequency chart, with averages indicated, plotted with frequencies as ordinates and temperature intervals as abscissæ.

MEAN DAILY TEMPERATURES FOR JUNE—1917 TO 1926
NEW YORK CITY
(From Reports of New York Meteorological Observatory)

Day	Year									
	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
1	58.3	81.4	66.8	71.2	68.2	65.0	68.4	60.7	79.5	63.5
2	60.9	83.4	77.6	76.1	61.4	65.0	76.2	63.2	77.6	71.5
3	68.2	76.6	80.0	75.2	65.3	66.4	72.0	64.7	80.0	60.2
4	65.9	69.2	81.6	62.1	68.8	74.0	75.5	62.6	87.0	57.5
5	67.3	70.8	76.1	53.7	63.2	72.1	80.7	64.8	87.5	55.4
6	67.1	67.0	70.9	59.0	65.1	71.5	78.4	62.7	87.4	58.3
7	64.8	70.5	76.3	62.7	65.9	78.7	70.0	68.7	83.8	57.8
8	70.8	65.2	58.6	63.4	65.5	80.0	60.6	57.4	65.3	64.8
9	72.9	71.1	56.3	64.0	66.7	79.2	61.0	61.1	67.8	69.3
10	68.2	67.8	64.9	67.0	66.1	78.0	66.2	60.0	75.9	70.4
11	65.9	59.3	72.1	78.9	70.7	75.7	65.8	57.3	65.4	68.6
12	68.4	70.1	66.5	72.0	74.9	70.0	66.7	57.7	67.0	62.1
13	64.0	63.1	69.5	62.8	73.8	62.2	62.2	59.0	68.4	69.1
14	66.2	62.7	70.0	73.0	67.9	65.8	72.1	64.0	74.3	70.1
15	64.8	66.8	68.6	77.8	68.6	66.4	66.9	70.3	80.2	67.4
16	64.3	66.5	68.9	74.5	71.2	66.2	68.2	73.0	73.3	58.3
17	63.8	70.2	70.5	60.4	64.1	68.6	72.6	68.9	67.1	60.2
18	70.6	68.1	68.8	55.9	70.3	70.4	72.7	72.1	78.3	67.3
19	72.8	68.2	68.8	61.0	64.1	70.9	78.4	71.9	71.3	66.1
20	74.4	59.6	70.7	62.0	69.6	66.4	85.1	64.2	72.5	62.5
21	73.9	60.3	74.8	64.8	76.8	66.8	86.0	70.2	71.0	62.6
22	77.1	65.8	67.1	70.2	81.1	66.6	73.1	77.2	72.0	69.8
23	76.1	54.0	69.6	68.7	77.6	69.9	72.1	75.7	70.4	63.5
24	75.6	67.0	79.5	69.4	80.0	73.0	78.2	79.2	67.4	68.8
25	70.9	66.6	73.5	69.8	78.0	72.0	85.1	75.5	66.4	72.7
26	72.8	65.0	69.9	74.0	70.3	67.9	80.5	69.8	71.1	69.1
27	77.1	65.8	71.0	74.0	74.7	65.8	75.0	63.2	73.2	69.2
28	73.1	62.3	65.4	76.0	72.4	75.2	70.8	69.6	72.5	70.7
29	72.4	63.5	59.6	74.3	77.0	75.5	67.6	76.2	73.0	74.4
30	71.6	69.5	65.0	73.8	68.3	76.9	66.9	71.3	68.3	75.9
Mean	69.3	67.3	70.0	68.3	70.3	70.7	72.5	67.1	73.8	65.9

Max. Mean Daily Temp. for period = 87.5
Min. Mean Daily Temp. for period = 53.7
33.8(12 = 3

Figure 3A

Tally Sheet
Mean Daily Temperature for June
New York City, 1917 to 1926

Mid Point of Class Interval		Frequency
55	𝍸	5
58	𝍸 𝍸 ||	12
61	𝍸 𝍸 𝍸 𝍸	20
64	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||||	39
67	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||	57
70	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||	62
73	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||	42
76	𝍸 𝍸 𝍸 𝍸 𝍸 ||||	29
79	𝍸 𝍸 𝍸 𝍸 |	21
82	𝍸 |	6
85	||||	4
88	|||	3

Class Interval is equal to the maximum mean daily temperature for the period minus the minimum mean daily temperature for the period divided by twelve. Conventionally no less than twelve groups should be used in plotting, and the class interval should be an odd number.

$$\begin{array}{r} 87.5 \\ \underline{53.7} \\ 12\overline{)\,33.8} \\ \hline 3 \end{array}$$

Determination of Averages

Mean: Sum of the product of the frequencies in each group by their respective mid-point values divided by total frequency.

$$\frac{20{,}871}{300} = 69.57$$

Median, or middle observation (determined by interpolation) = 69.32

Mode, most frequent observation determined by formula,

$$\text{Mode} = \text{Mean} - 3\ (\text{Mean} - \text{Median}) = 68.82.$$

Figure 3B

COMPUTATIONS FOR DETERMINING THE MEAN (Slow Method)

Temp. (Group Mean) (X)	Frequency (f)			Product (fX)
55.0	5	(5)		275
58.0	12	(17)		696
61.0	20	(37)		1,220
64.0	39	(76)		2,496
67.0	57	(133)		3,819
70.0	62	(195)	(167)	4,340
73.0	42	(105)		3,066
76.0	29	(63)		2,204
79.0	21	(34)		1,659
82.0	6	(13)		492
85.0	4	(7)		340
88.0	3	(3)		264
Sum	300			20,871

$$\text{MEAN} = \frac{20,871}{300} = 69.57$$

Figure 3C

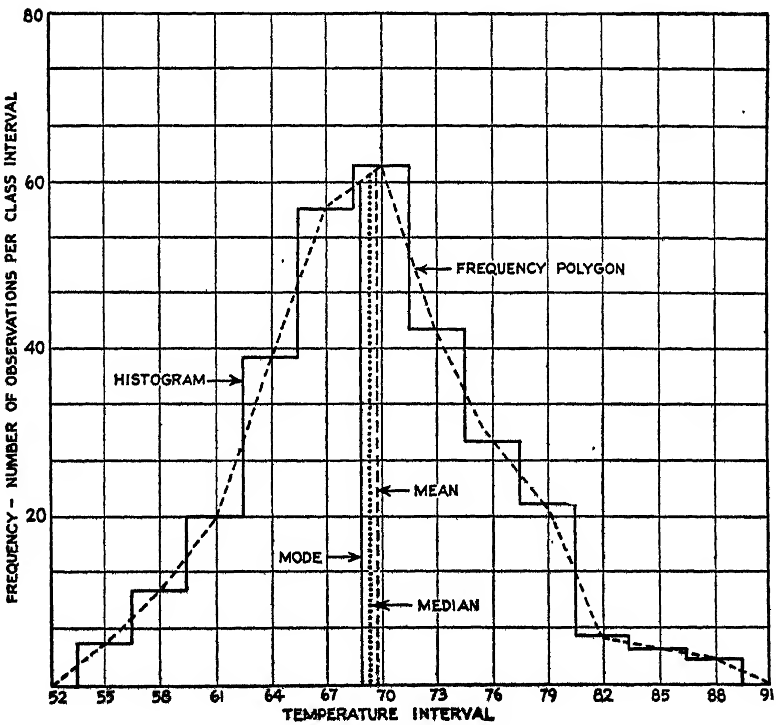


Figure 3D

Sketches.—Two varieties of sketches—pictographs and cartograms—as well as many other types, are available to the writer of reports. In this form of statistical presentation he is limited by his dexterity alone.

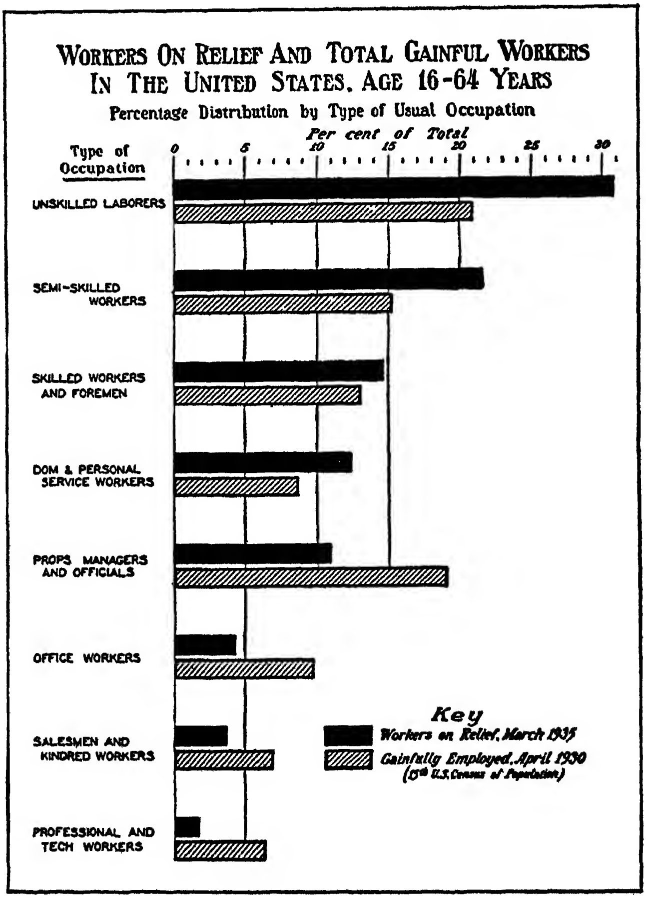


Figure 4. Bar Chart

(From *Report on the Works Program*, Washington, D. C., 1936, by the Division of Research, Statistics, and Records of the Works Progress Administration)

PICTOGRAPHS.—The pictograph consists of a series of bars, blocks, circles, or outline sketches of objects employed to emphasize variations in size, quantity, or number. The bar graph,

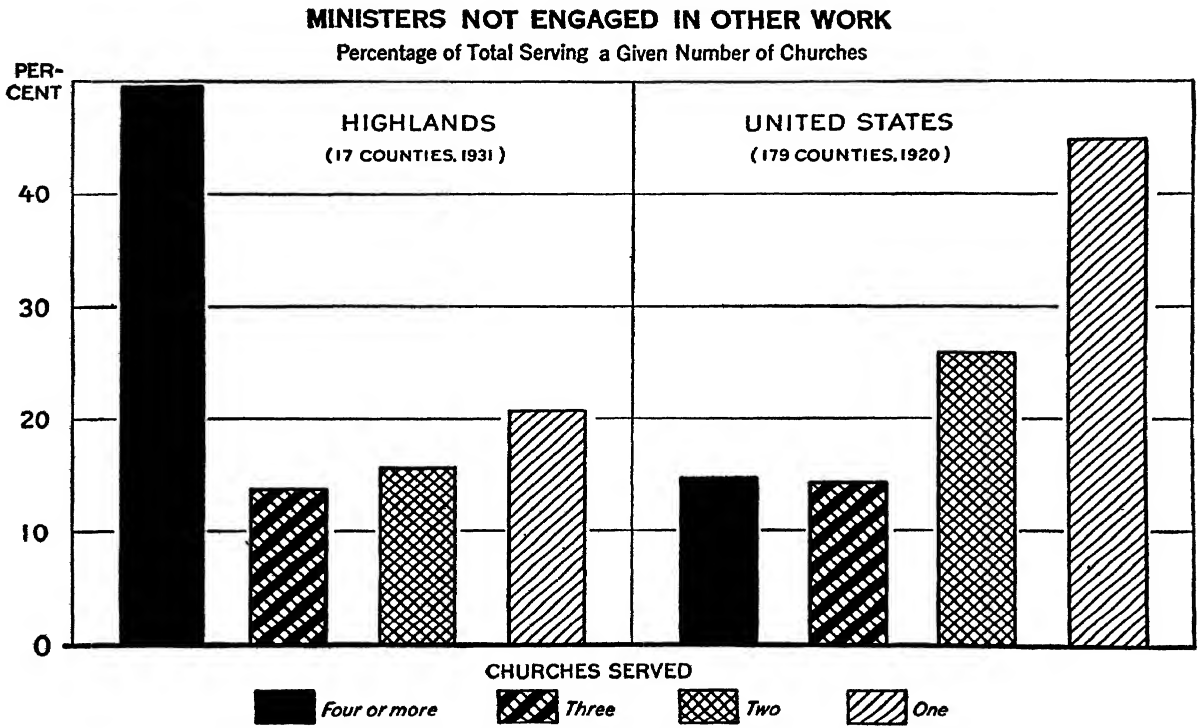


Figure 5. A Simple Bar Chart Comparing Two Related Groups of Data
(From *Economic and Social Problems and Conditions of the Southern Appalachians,* U. S. Department of Agriculture Miscellaneous Publication 205, Washington, D. C., 1935)

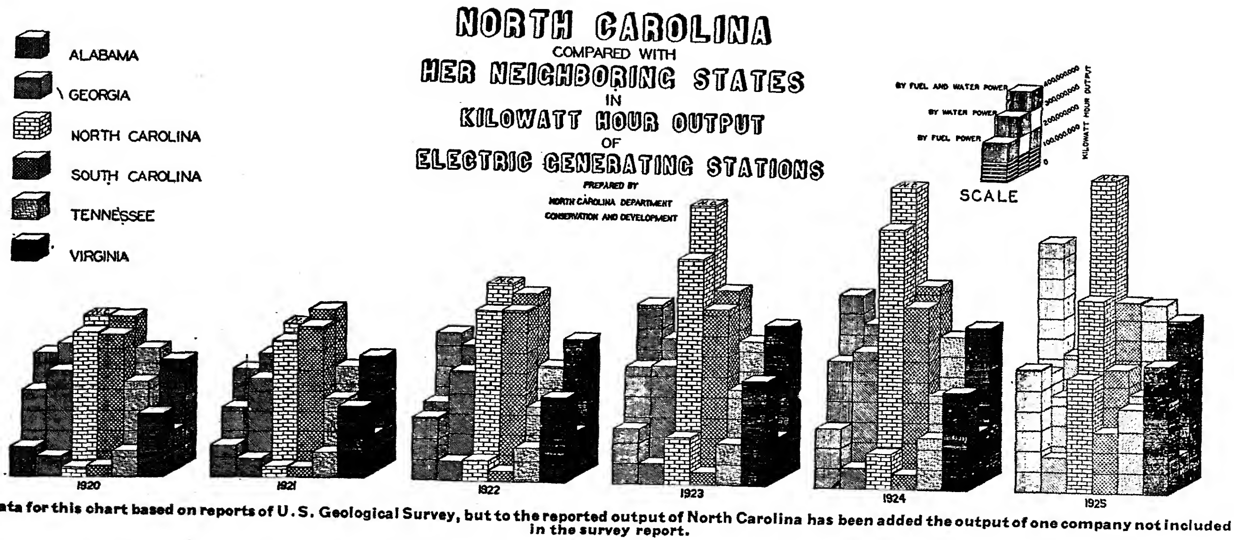


Figure 6. A Three-Dimensional Bar Chart

(From *The Power Situation in North Carolina*, by Thorndyke Saville, C. E. Ray, and G. Wallace Smith, Circular 16 of the North Carolina Department of Conservation and Development, Chapel Hill, N. C., 1925)

illustrated in Figure 4, is perhaps the commonest form of pictograph. In it comparisons are indicated by the lengths of bars representing the magnitude of the data. The bars should be made wide enough and spaced far enough apart to make each stand out from the other. They may be either vertical or horizontal. If descriptive material is to accompany each bar, the horizontal arrangement is preferable. Sometimes it is possible to compare several different sets of facts by means of shaded or colored bars, as in Figures 5 and 6. The latter graph uses a unique three-dimensioned bar.

Segmented Bar Graphs.—Another form of bar graph makes use of segmentation, the total length of the bar representing 100% of the data and various portions differentiated by shading representing divisions of the whole. Such segmented bar graphs are especially useful in comparing activities over different years in the same company or during the same year in different companies. This type of bar graph is illustrated in Figure 7.

Although blocks, circles, and other simple geometric figures are often used in presenting statistics, they have an obvious disadvantage. They show magnitude by change in area; and area in a geometric figure, either plane or solid, does not vary as the length of the side but as the square or the cube of the side. Since the eye grasps length more accurately than area, it is possible that a reader may not judge correctly the relation between two squares or two cubes of different size. If, however, each figure represents a definite quantity, the difficulty is less. Hence geometric figures are often used in combination with maps to indicate graphically both distribution and quantity of products.

Pie Diagrams.—One form of chart, the pie diagram, obviously named, is commonly used to show how a whole quantity is divided into its component parts. Figure 8, from the *Report of the National Resources Board,* is an elaborate "pie diagram" of interest to every American. Simpler ones, illustrating heat laws, company income, or expenditure, are common in statistical studies.

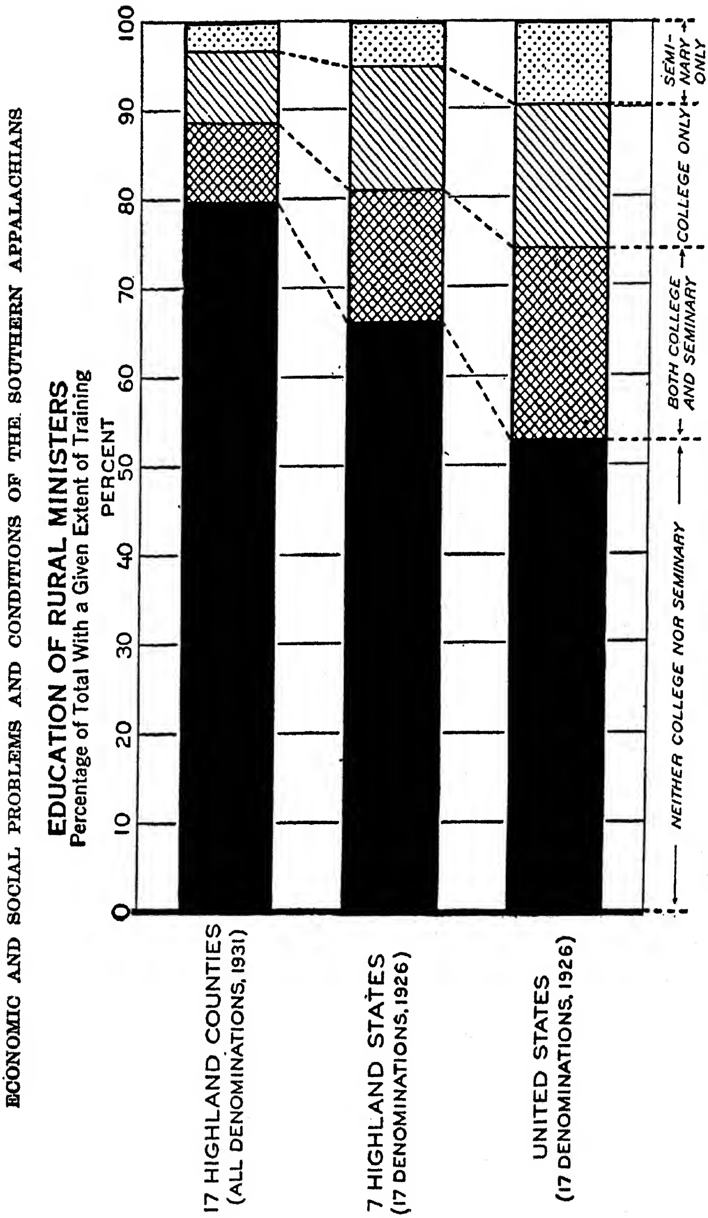


Figure 7. A Bar Chart Showing Segmentation

(From *Economic and Social Problems and Conditions of the Southern Appalachians*, U. S. Department of Agriculture Miscellaneous Publication 205, Washington, D. C., 1935, p. 177)

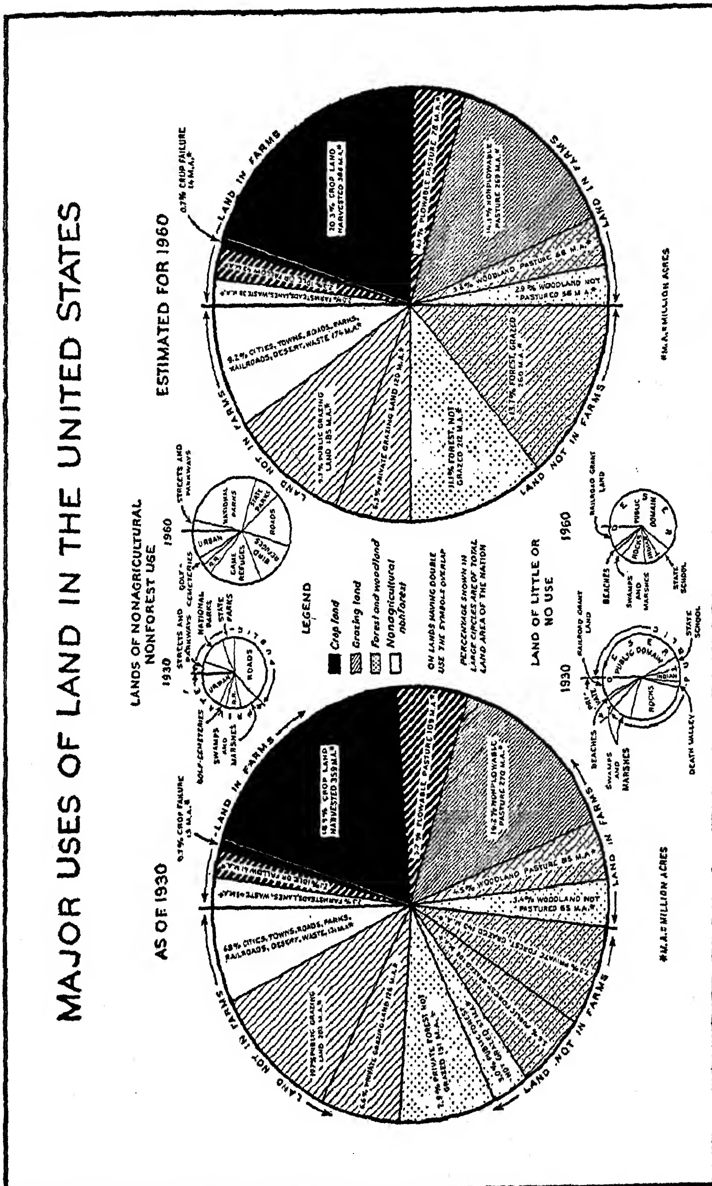


Figure 8. An Elaborate Pie Diagram
(From *National Resources Board Report*, Washington, D. C., December, 1934, p. 108)

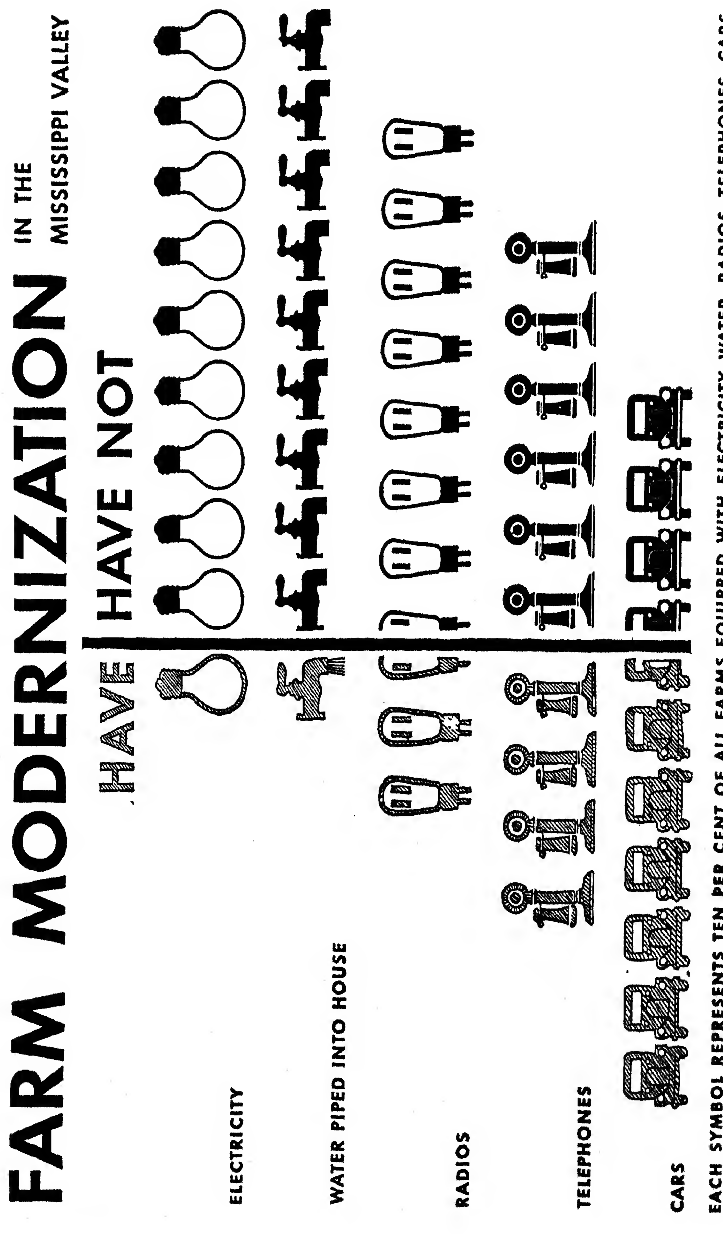


Figure 9. A Chart in Which Pictures Are Used to Represent Quantities
(From *Report of the Mississippi Valley Committee of the National Resources Committee*, Washington, D. C., October, 1934, facing p. 52)

Where popular appeal is more important than accuracy, pictures may be made to symbolize quantities, as in Figure 9, a striking representation of the facts (*Report of the Mississippi Valley Commission*). Here each picture represents by area a unit arbitrarily determined. In other forms, the height of a building or the length of a ship may take the place of a conventional bar graph to indicate the magnitude of the data. The possibilities for pictures in graphical presentation are limitless and the increasing importance of visual methods of conveying statistical facts is attested by the elaborate illustrations in many recent reports, both public and private. Printed on glazed paper, profusely illustrated with photographs, charts, and graphs, they appeal to the eye so vividly that the average reader who would never examine tables is arrested and compelled to grasp the facts thus portrayed.

CARTOGRAMS.—As the name suggests, cartograms are charts which present distribution of data in space, either actually or symbolically. Although the data may be presented in a variety of forms, they are usually shown by shading, by lines connecting comparable data, or by conventional symbols.

Maps form the commonest class of cartograms. Shading, colors, symbols, and lines may be used to show distribution of the data as in Figure 10 from the *Report of the Mississippi Valley Commission.* Government weather maps and maps showing distribution of population or a company's product or location of mines, factories, or forests illustrate other uses of the map cartogram. An excellent example is Figure 11, from *A Report to the Mayor and City Council on Flood Protection for the City of Columbus, Ohio* (1913), which indicates the value per acre of real estate in Columbus and vicinity. The illustration in Figure 12 shows a slight variation in method, in that on this map values are shown in the form of percentages rather than as dollars and cents.

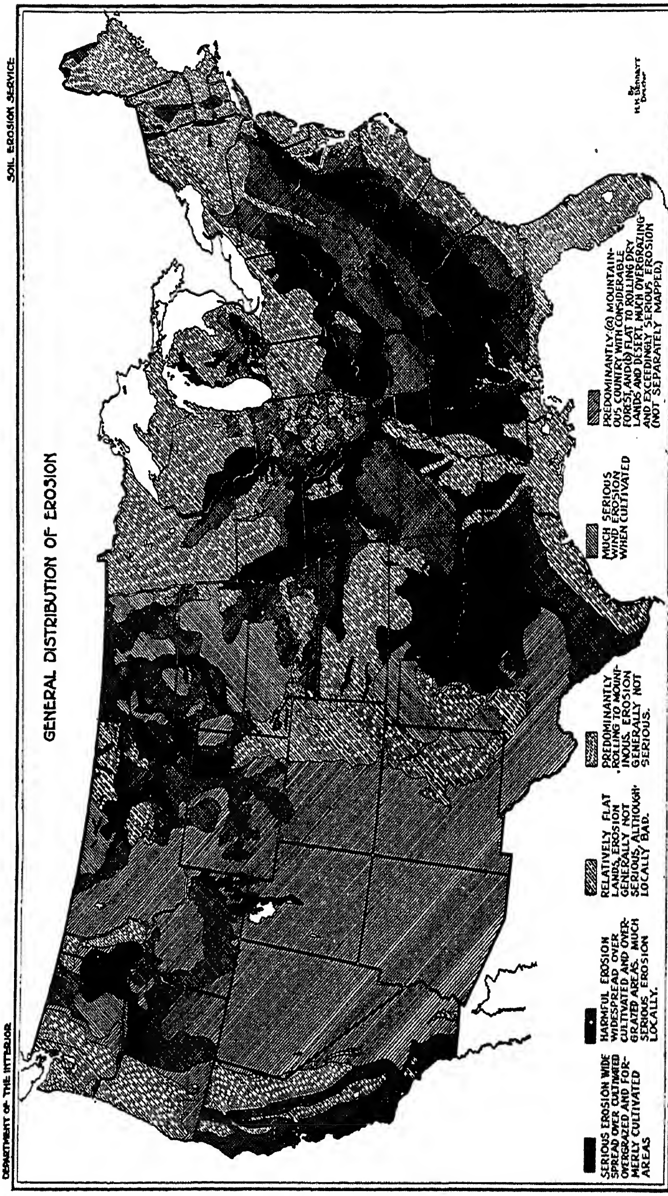


Figure 10. A Cartogram Showing Distribution

(From *Report of the Mississippi Valley Committee of the National Resources Committee*, Washington, D. C., October, 1934, p. 62)

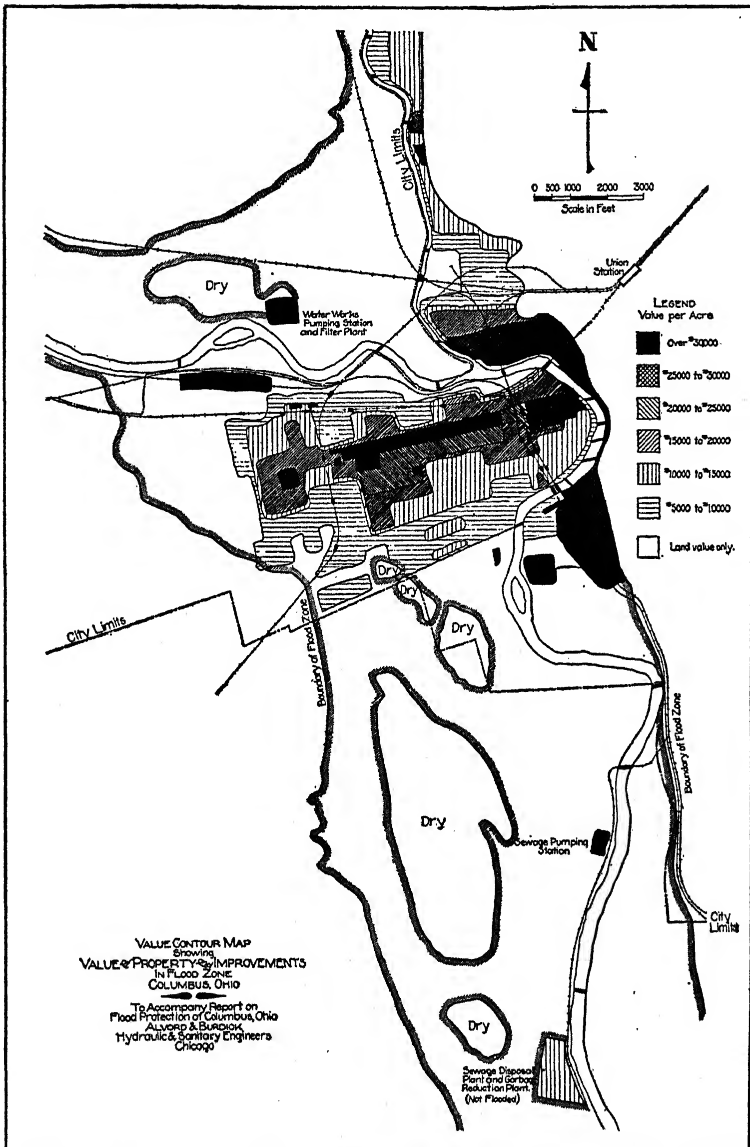


Figure 11. Another Illustration of a Cartogram
(From *A Report to the Mayor and City Council on Flood Protection for the City of Columbus, Ohio,* by John W. Alvord and Charles B. Burdick, September 15, 1913)

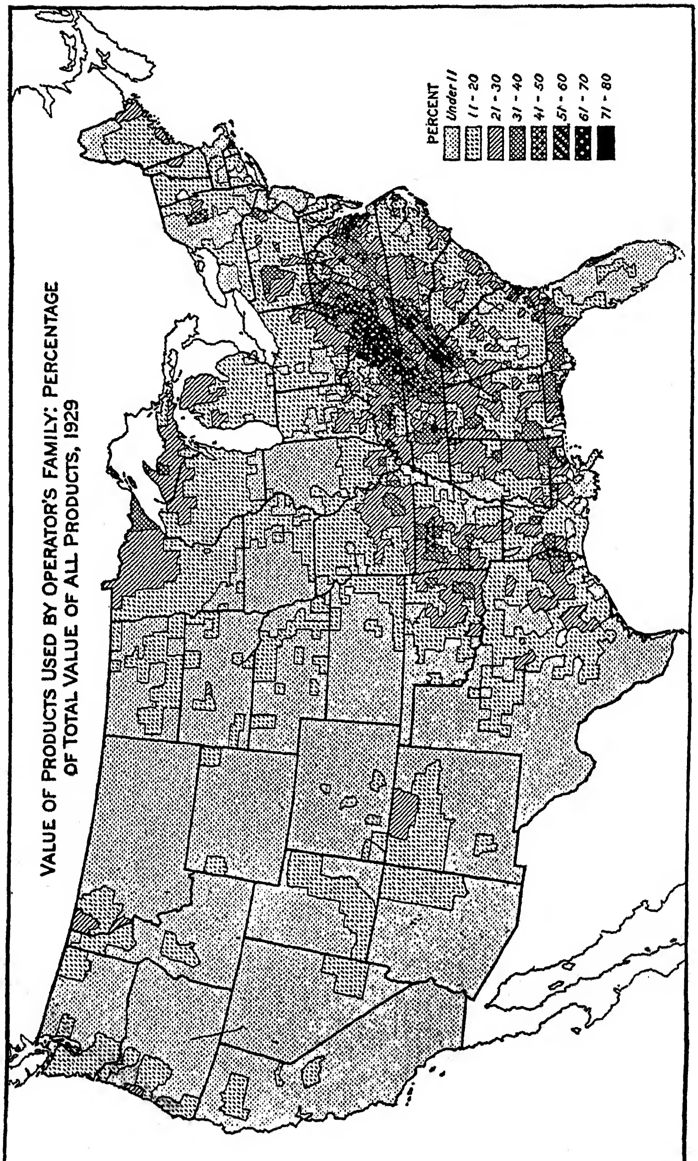


Figure 12. A Cartogram Indicating Values by Shading

(From *National Resources Board Report*, Washington, D. C., December, 1934, p. 180)

Flow-Sheets.—Symbolically the route or flow of a product from raw material to finished article may be illustrated on a cartogram called a flow-sheet. Sometimes the route may be merely suggested by straight arrow lines moving from one

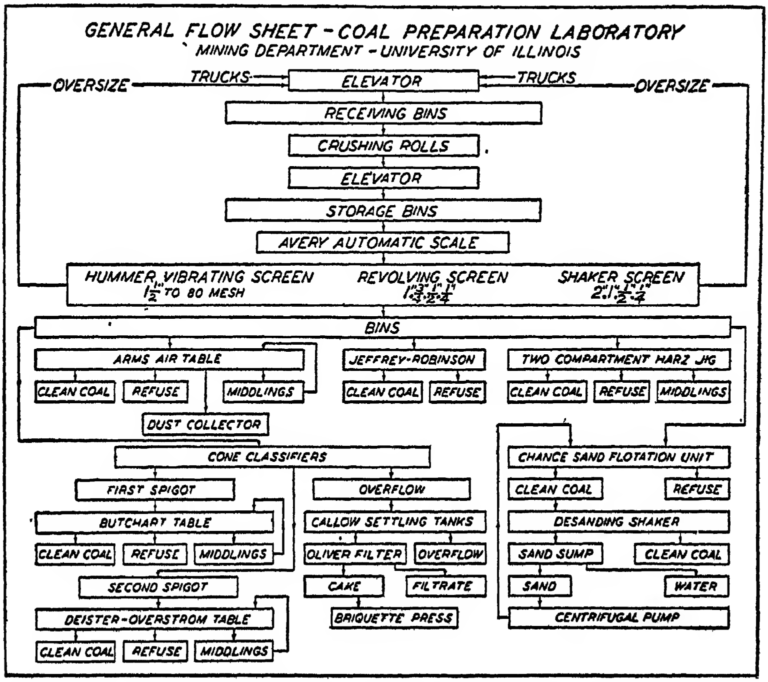


Figure 13. A Flow Sheet Indicating Flow of Work in a Coal Preparation Laboratory

(Reprinted by permission from *Engineering Drawing*, 3rd Ed., published by John Wiley and Sons, Inc., 1935, p. 340)

machine or process (indicated by a block or circle) to another as in Figure 13. A more attractive chart may be obtained by sketching the actual apparatus and indicating the direction of flow of the product by lines and occasionally indicating different paths by colors. Such flow-sheets are often used in the metallurgical and chemical industries. Figure 14 shows such a chart.

Routing Charts.—Similarly, routing charts may indicate how material moves from point to point in a factory and thus show graphically the most efficient layouts. Indeed, by means

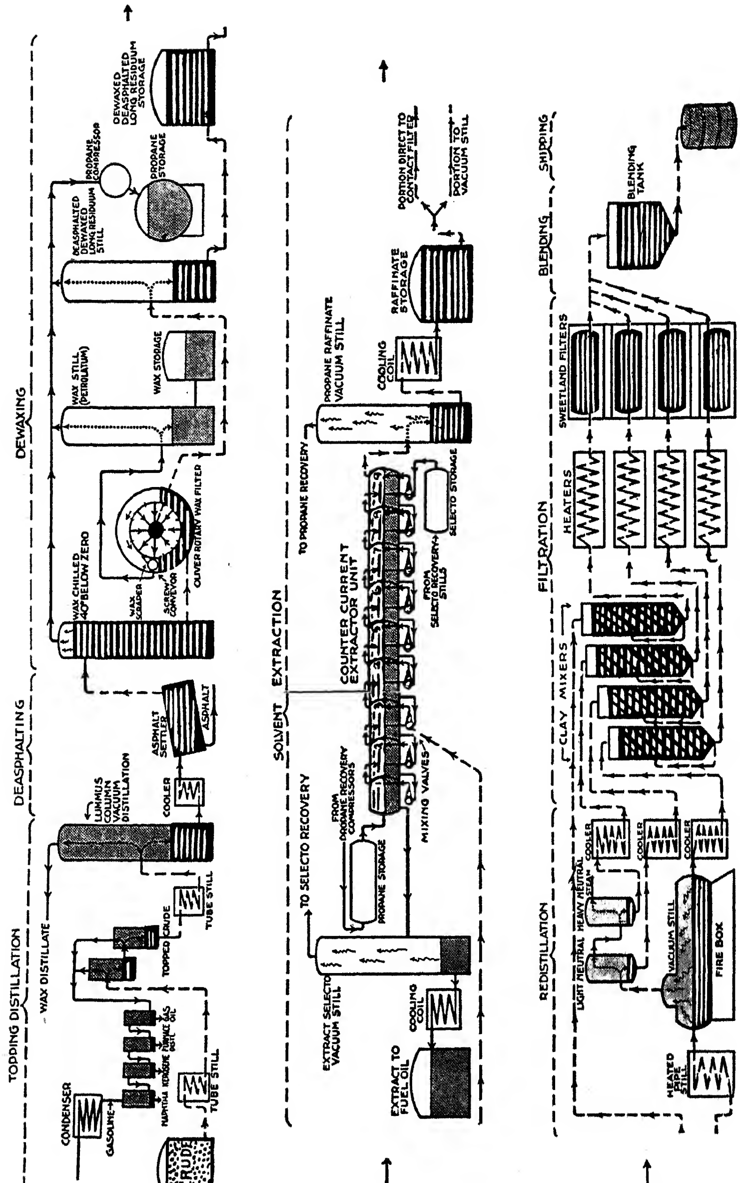


Figure 14. Cartogram Showing Manufacture of a Product

The black portions with white stripes and the dotted lines are red in the original.

(From *Panorama of Lubrication*, Vol. 1, No. 3 (1936), published by Shell Petroleum Corporation, St. Louis, Missouri.

PROCESS FLOW CHART
Coil Spring

Operation	Distance
Raw stock stores	
To scales	15
(1) Weigh	
To spring job	550
Ahead of operation	
To winding machine	20
(2) Feed into machine	
(3) Wind	
(4) Cut-off (10 ft. length)	
To bench for cut-off	8
(5). Cut-off (1 pc. length)	
(6) Pick up and place in pan	
To bench	15
(7) Grind both ends	
(8) Place for transportation	10
Surplus Raw Stock	
To raw stock room	550
(9) Weigh	
(10) Replace balance of material	15
Raw stock stores	
Wait for trucking	
(11) Load on electric truck	
To elevator	60
Up-(1) floor	15
To inspection room	200
(12) Unload	
To inspection bench	8
[13] Inspect	
Place for transportation	8
Wait for trucking	
(14) Load on electric truck	
To elevator	200
Up-(1) floor	15
To heat treat[1]	600
(15) Unload	
To bench	25
(16) Place in wire basket	
To niter tank	15
(17) Heat	
(18) Quench	
(19) Dip in oil	8
To bench	7
(20) Empty into pan	
Place for transportation	25
Wait for trucking	
(21) Place on electric truck	
To inspection room	70
(22) Unload	
To bench	18
[23] Inspect	
Place for transportation	18
Wait for electric truck	
(24) Load on truck	
To elevator	680
Down (1) floor	15
To inspection room	200
(25) Unload	
To bench	8
(26) Place on rods	
Set	
(27) Remove from rod, place in pan	
Place for transportation	8
Wait for trucking	
(28) Load on electric truck	
To elevator	200
Up-(1) floor	15
To P.S.	440
(29) Unload	
Part stores	
	4,041 Ft.

SUMMARY

Number of Operations	29
Number of movements by man	16
Number of movements by elevator	4
Number of movements by electric truck	5
Number of waits for trucking	5
	59

Total distance traveled – 4,041 feet

- ◯ Denotes an operation
- ○ Denotes a transportation
- Denotes a temporary storage
- ▽ Denotes a permanent storage
- □ Denotes an inspection

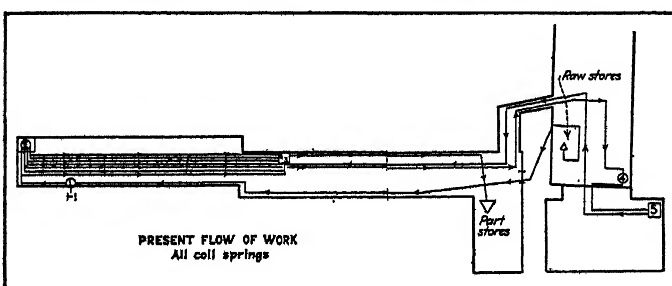


Figure 15. A Process Flow Chart and a Flow Diagram Used for Analyzing Plant Operations and Layout

(From an article by Allan H. Mogensen, Consulting Editor, in *Factory Management and Maintenance*, December, 1934)

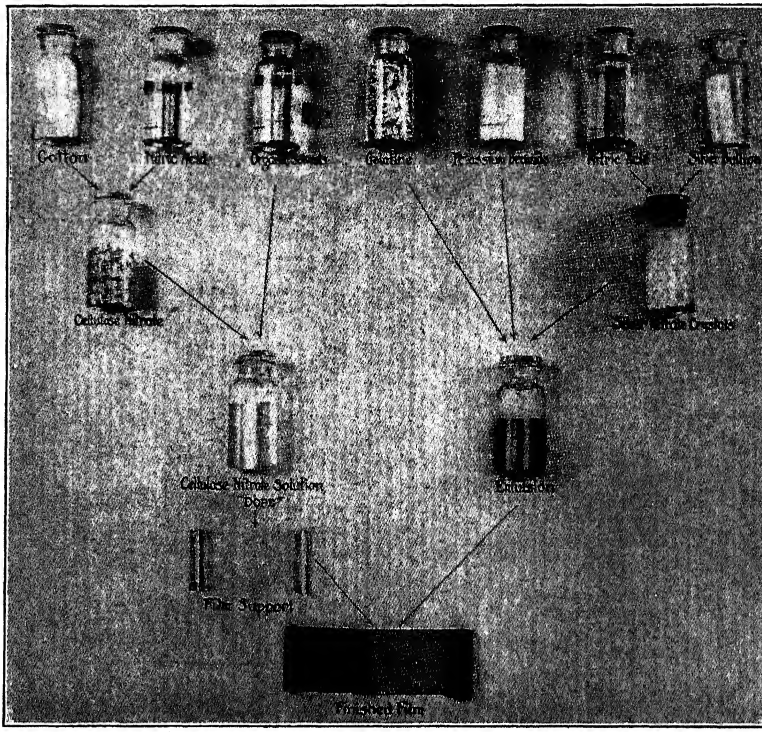
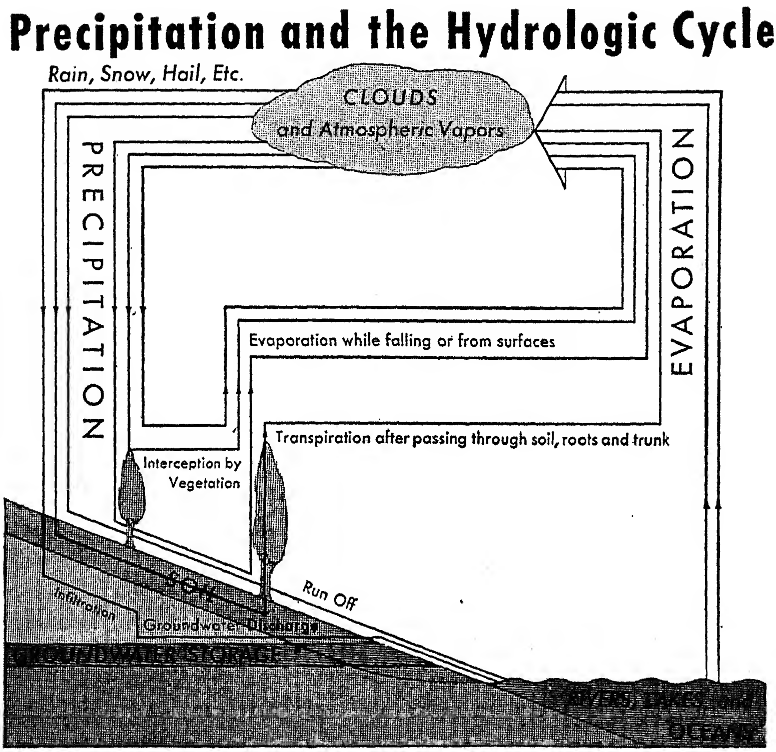


Figure 16. A Photographic Product Analysis
(From *Annual Report of the Eastman Kodak Company*, 1929)

of symbols and scales such charts may be made to tell the entire story of a process and to point to possible saving in time and effort in production. An interesting example from *Factory Management and Maintenance* for December, 1934, is reproduced in Figure 15.

SPECIAL FORMS.—Product analysis may also be exhibited by charts, either symbolically or actually, through photographs like the one in Figure 16 from the *Annual Report of the Eastman Kodak Company*. Indeed, the cartogram may assume all sorts of ingenious forms, such as the two below from *A Report on National Planning,* showing the hydrological cycle (Figure 17) and the consumption cycle (Figure 18), for often the complicated relationships of today are revealed more clearly by pictures than by words.



PICTORIAL STATISTICS, INC

"A drop of water, evaporated from the ocean, rains five times."—Anonymous

Figure 17. An Ingenious Cartogram from a Modern Report
(From *National Resources Board Report,* Washington, D. C., December, 1934, p. 262)

One Consumption Expenditure Starts Many Income Cycles

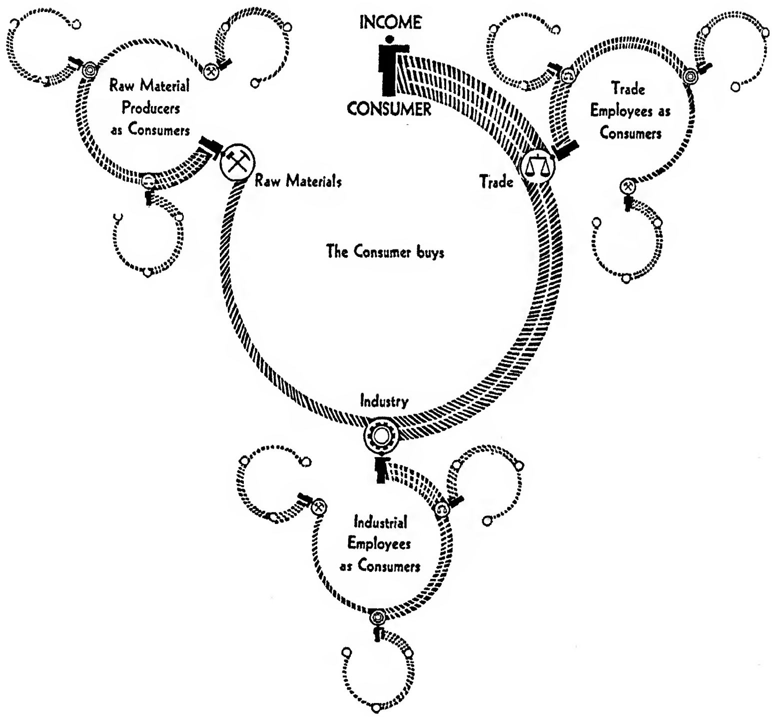


Figure 18. Another Ingenious Cartogram
(From *National Resources Board Report,* Washington, D. C., December, 1934, p. 362)

Organization Charts.—Management charts, another development in the graphical presentation of data, deal with the relation of the various parts of an organization to the responsible officials in the company or show the departmental organization of a corporation. Figures 19 and 20 illustrate two varieties of such charts.

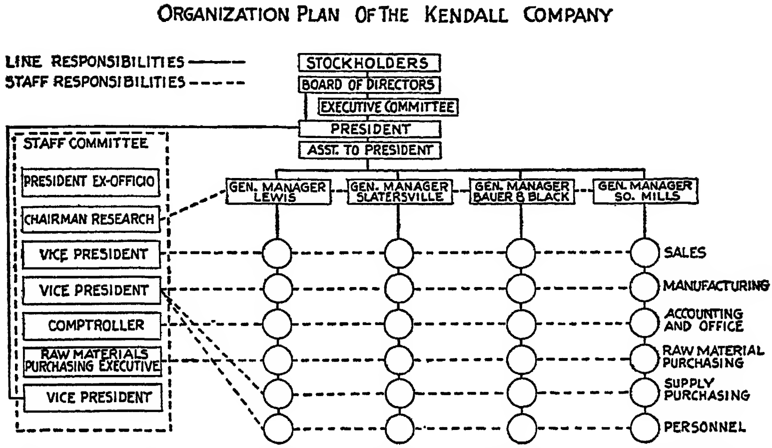


Figure 19. A Typical "Line and Staff" Organization Chart Showing Direct Authority by Solid Lines and Advisory Responsibility by Dotted Lines
(From *Management Problems*, edited by G. T. Schwenning, University of North Carolina Press, Chapel Hill, N. C., 1930)

Literal Interpretation of Statistics.—In addition to the presentation of statistics in tables and in charts, it is often wise to explain the value and purpose of the data in the body of the report by means of paragraphs of exposition and comment. These call attention to maxima and minima and to averages, trends, and tendencies. They may deal with unusual features and discrepancies or they may indicate the methods used to derive the curves or the formulas underlying a calculation which has been plotted. In short, they attempt to clarify all the implications of the statistics.

An instance occurs in "Who Paid the Processing Taxes," *Southern Economic Journal,* III, 263 (January, 1937), by Wirth F. Ferger:

(1)

In Table I are given the indices of the non-agricultural national income and the agricultural cash income from 1929 through 1935. . . . The income figures suggest that recovery in agriculture commenced prior to that in non-agricultural industry. Whereas the non-agricultural national income declined from 1932 to 1933 from 63% to 59% of its 1929 level, the recovery in agricultural cash income began in that year, rising from 42% in 1932 to 49% in

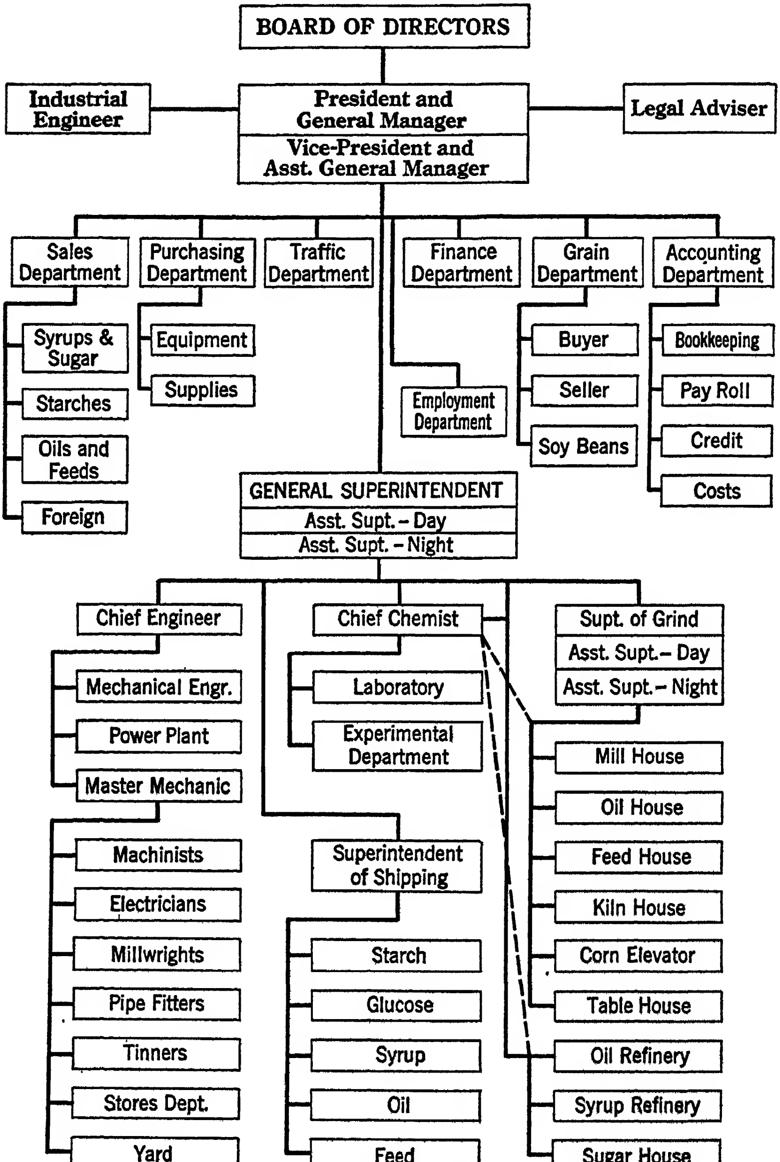


Figure 20. A Typical Organization Chart for a Large Company
(From A. G. Anderson, *Industrial Engineering and Factory Management*, Ronald Press, 1928, p. 62)

1933. The annual figures are in this case misleading, however, for the monthly data, corrected for normal seasonal variation, show that the first quarter of 1933 marked the low point in both cases. Agricultural income took a tremendous temporary spurt in the second quarter because of the speculative rise in raw material prices and the sales by farmers of stocks that they had refused to give away. A reaction occurred later in the year before the sound recovery under the A.A.A. took place. The true significance of the income figures lies in the evidence of the much more rapid and pronounced recovery in farm income than in industrial. By 1935, farm income had risen 65% above its low point of 1932, while non-agricultural income had risen only 19% above its 1933 trough. The greater recovery in agricultural income followed of course a much greater decline in non-agricultural income so that, as Table I shows, the two were on a substantial parity with each other in 1935.

TABLE I. INDICES OF NATIONAL AGRICULTURAL AND NON-AGRICULTURAL INCOME AND RETAIL SALES, 1929—1935

Year	Agricultural Cash Income[a]	Agricultural Net Cash Income[b]	Non-Agricultural National Income[c]	Rural Sales General Merchandise[d]	Department Store Sales[e]
1929	100	100	100	100	100
1930	77	70	93	78	92
1931	56	47	80	62	83
1932	42	32	63	51	62
1933	49	50	59	55	60
1934	60	63	66	67	68
1935	69	74	70	80	70

[a] Bureau of Agricultural Economics index of value of qualities actually sold off the farms of the state where produced, and rental and benefit payments. Excludes value of products consumed on farm where produced.

[b] B.A.E. index of above cash income, less all actual production expenses except cash wages of hired help. Represents net cash income to farmers, including farm hands.

[c] Department of Commerce estimates of national income, including direct relief, less the agricultural items and farm rent paid to non-farm persons.

[d] Department of Commerce index of Ward, Roebuck, and Penney sales.

[e] Federal Reserve Board index of department store sales.

All three methods of interpreting statistics are often combined. Tables are supplemented by charts or sketches which, in their turn, are supplemented by generalizations such as those contained in the paragraphs quoted.

Example of Interpretation of Statistics.—A combination of this kind is to be found in the *Report of the Transit Commissioner, City of Philadelphia:*

(2)

Population and Housing Statistics

The enormous growth of population of large cities has been accompanied, especially during the past decade, by the development of systems of high-speed transportation. The theory has been advanced that this growth has been caused in part, or accelerated, by these rapid transit systems. While other factors probably have had greater influence upon this rapid growth of population, the converse of the proposition is undoubtedly true; namely, that this large growth necessitates swift, convenient, and comfortable transit between business centers and from them to residential districts, and if this transportation is not forthcoming, it not only places an economic handicap upon the city's workers but also tends to prevent normal growth of the city's population by retarding the development of business and industries.

Metropolitan Area

A study of the growth of population of the four largest American cities during the past 50 years is of interest to develop the tendencies of the future. In order to place these statistics on the same basis, it has been assumed that a circular area, the center of which is at the City Hall, will embrace the same character of population for each city. The radius of this circle has been taken as 16 miles, this for Philadelphia including the entire area within the city limits and also the populous centers of Chester, Norristown, Camden, and the New Jersey suburbs. The extreme limits of this circle will also represent about one hour's time of transit from business house to residence by rapid transit or steam railroad, allowing for time to stations and for train connections. While this Metropolitan area for Boston probably covers more than the actual urban and suburban territory comprising that city, and while for New York it does not comprise the entire suburban territory, it represents for Philadelphia and Chicago nearly the actual present Metropolitan limits and can be fairly assumed for purposes of comparison for all of these cities.

While a study of population and transportation statistics of large foreign cities was made, it was determined not to include them in this report. . . .

Population

The population by decades of these four Metropolitan cities for the past fifty years is as follows:

TABLE NO. 21

POPULATION

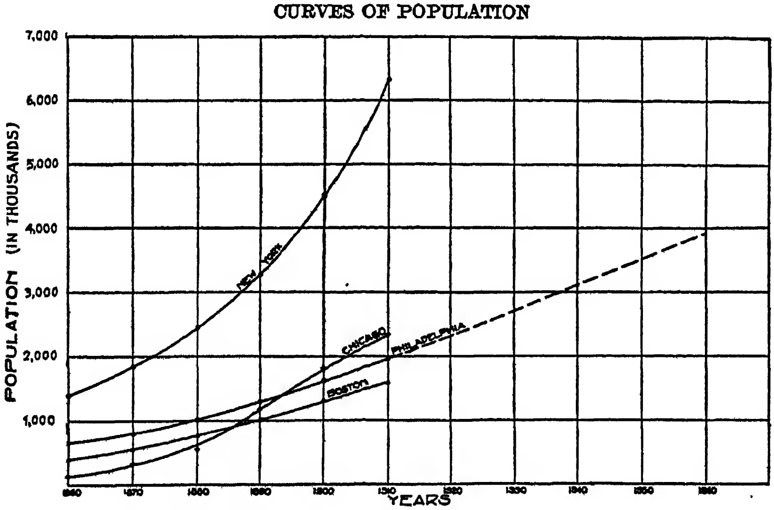
(U. S. Census)	New York	Chicago	Philadelphia	Boston
1860	1,385,394	123,821	663,686	407,960
1870	1,840,968	317,572	799,940	563,005
1880	2,425,888	536,743	1,022,428	769,753
1890	3,241,750	1,163,100	1,279,878	1,002,288
1900	4,492,771	1,793,932	1,599,696	1,293,694
1910	6,313,207	2,340,627	1,940,833	1,573,345

The relation of these figures appears more closely upon the accompanying Diagram No. 7, where the population is shown by curves.

It is apparent that while the Metropolitan areas of Chicago, Philadelphia, and Boston are fairly comparable as to size and rate of growth, Metropolitan New York, containing a population of 6,313,207, is larger than the sum of the other three cities, amounting to 5,874,805. Consequently, any deductions based upon the experience in New York should be applied with care to the others.[2]

DIAGRAM NO. 7

CURVES OF POPULATION



[2] An interesting exercise would be to bring up to date the tables and curves in the following pages, which are complete only to 1910.

INCREASE OF POPULATION

For future estimates in these metropolitan areas, it is necessary to examine more especially the relative increases of population per decade, which have been as follows:

TABLE No. 22

INCREASE OF POPULATION

Decade	New York	Chicago	Philadelphia	Boston
1860–1870	455,574	193,751	136,254	155,045
1870–1880	584,920	219,171	222,488	206,748
1880–1890	815,862	626,357	257,450	232,535
1890–1900	1,251,021	630,832	319,818	291,406
1900–1910	1,820,436	546,695	341,137	279,651

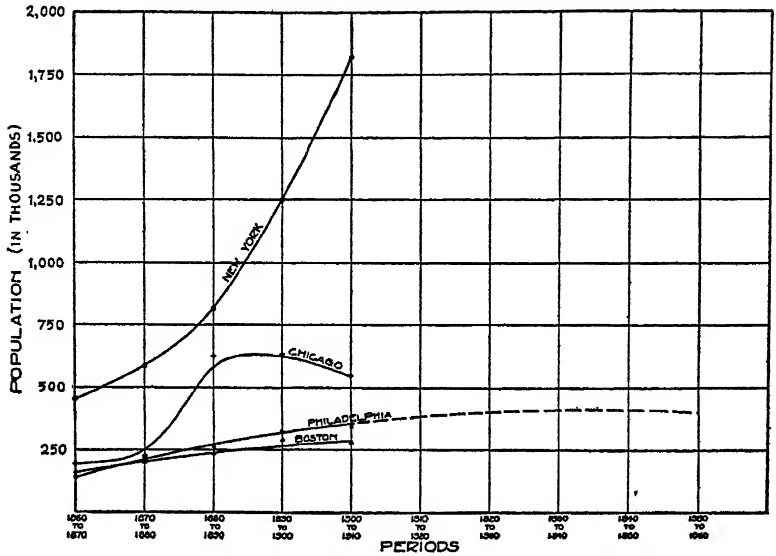
From this table two salient features appear. The first is the enormous increase of New York's population, both in amount and in cumulative totals. The increase for the decade to 1910, of 1,820,436, amounts in itself to a population almost as large as that of Metropolitan Philadelphia. The cumulative increase, or the growth of the increase for each decade, is also very remarkable, and while this increment amounted to about 200,000 persons for the decades ending 1880 and 1890, it advanced to over 400,000 for the decade ending 1900 and to nearly 600,000 for the decade ending 1910. Up to 1900 this cumulative growth of the increase is in evidence for the three other cities. In the case of Chicago and Boston, however, for the decade ending 1910, there is a smaller increase than for the previous decade, and this brings out the other interesting feature of this table—that Philadelphia is the only one of these other large cities which shows a steady growth or cumulation of the decade increases and in this particular, although to a much less extent, follows the increase of Metropolitan New York.

The accompanying Diagram No. 8 shows clearly by curves the tendency of these cumulative increases.

Here will be noted again the enormous rate of growth of New York City, placing it distinctly in a class by itself as representing the largest continued increase of population in a given time, probably, of any city in the history of the world. The other three curves indicate a gradually declining tendency, the Chicago and Boston curves both showing that this decline in the amount of decade increases has already taken place.

DIAGRAM NO. 8.

CURVES OF DECADE INCREASES IN POPULATION



ESTIMATE OF FUTURE POPULATION

In order to project the population of Philadelphia into the future, its curve of decade increases has been extended to the year 1960, and this shows that these decade increases reach a maximum in 1950, decreasing slightly thereafter. These estimated decade increases developed by this curve and the total equivalent population per decade for Metropolitan Philadelphia are as follows:

TABLE NO. 23

ESTIMATED POPULATION OF PHILADELPHIA

Year	Metropolitan Increase Past Decade	Population	
		Metropolitan Area	Within City Limits
1920	375,000	2,316,000	1,825,000
1930	395,000	2,711,000	2,108,000
1940	405,000	3,116,000	2,391,000
1950	408,000	3,524,000	2,669,000
1960	402,000	3,926,000	2,936,000

The above estimate of population is shown on Diagram No. 7 by the extension of the curve of population of Metropolitan Philadelphia, which, because of the even rate of decade increases, is, for all practical purposes, a straight line.

With regard to the rate of growth of Metropolitan Philadelphia, it is interesting to note that in the 50 years, from 1860 to 1910, the population trebled, while for the 50 years, from 1910 to 1960, the estimate shows that the population will double. The population estimate for 1960 of 3,926,000 represents approximately the combined present population of Metropolitan Chicago and Boston, or is equivalent, approximately, to the population of Metropolitan New York in 1896.

Since tables are often the result of difficult computations which must be completed before the report is begun, and since these computations may be required for verification, they are sometimes included in the appendix. For the same reason, more detailed tables are occasionally added.

Exercise: The Interpretation of Statistics.—Interpret one of the following groups of statistics. Employ the method or combination of methods—tabular, graphic, or literal—that seems best adapted to your material. In analyzing it, consider all significant points of view. For instance, in interpreting the academic standing of six fraternities, include references to subjects, departments, and years. Many of the essential facts will be found in the sources mentioned on page 199.

The academic standing of six fraternities; the areas of the agricultural districts in the United States; the areas of the Great Lakes; the capacity of silos in tons according to inside heights and diameters; the clearances at twenty great ports; the coal reserves of the world; the cost of building in twenty cities; the deaths from automobile accidents during the last five years; the debts of the ten leading nations; the degrees from different universities held by the members of the faculty; the distribution of students in the various courses; the extent and value of the crops in your state during the last ten years; the fluctuation in wages since the depression of 1929; the football scores made by ten colleges during the season; the groups of professional men listed in the city directory; the groups of students from different states or countries; the immigration quotas under the Restrictive Act; the imports and exports of the United States during a recent decade; the injuries and deaths from railroad accidents during the last five years; the location and altitude of the fifty highest points in the United States or Canada; the location and area of the parks in a city; the location and capacity of the chief submarine cables; the losses by fire

in the United States during the last twenty years; the melting points of six elements; the minimum and maximum temperatures in a district during each month of a five-year period; the number of buildings of each type in five city blocks; the number of students in ten institutions; the number of trees of each species on the campus; the occupations of the members of the local legislature; the prices of the bodies and principal parts of ten automobiles; the production of minerals in the United States; the production of newsprint in Canada during the last five years; the production of pulpwood in the United States during the last five decades; the production of steel in Europe during the last ten years; the production of tungsten in each country; the salaries at which college graduates enter the professions; the size of the farms in the different states; the size and value of the corn crop in the United States during the last ten years; the strikes and lockouts in a state or province during a year; the tensile strength of six materials; the traffic in a year on the four largest canals in the world; the value of the farm property in the different states or provinces; the selling price of automobile tires during a ten-year period.

CHAPTER 8

INFORMATION REPORTS—SPECIAL

Forms of the Special Report.—The wide range of the information report has been emphasized in Chapter 5. In addition to public and private reports prepared regularly at the end of stated intervals such as a day, a week, a month, or a year, innumerable reports are prepared on special occasions when information on a particular point is required. An architect, for example, may wish to learn from a contractor the amount of material which he has on hand. The manager of a factory may wish to learn from an employment agent the number and nationality of the laborers available. The head of a firm of manufacturers may wish to obtain from one of the chemists in the plant laboratory an opinion regarding the value of a process which has just been placed on the market; and the management of a corporation may wish to obtain from an accountant a statement regarding the cost of maintaining a department of whose value there is some question. For those who have read carefully the first three chapters of this volume, the preparation of such reports ought not to be a difficult task. The arrangement of material follows exactly the plan outlined. Three special situations, however, deserve additional treatment because of the specific problems involved: (1) When it is necessary to secure information regarding a project which has been proposed but not seriously studied; (2) when it is advisable to record the state of progress of a project or a series of experiments; and (3) when it is essential to prepare a permanent record describing a completed project. In all of these situations the text reflects certain methods which have been sanctioned by experience.

Characteristics of the Preliminary Report.—The preliminary report grows out of problems concerning the advisability

of locating a structure or constructing it, of manufacturing a product or marketing it, of changing methods or designing and installing apparatus; in short, a preliminary study usually precedes any important development in the field of engineering or of business. In many respects it is similar to the examination report considered in Chapters 9-12. Like the examination report, it usually leads to a recommendation. Unlike the examination report, however, it is based immediately upon experience. The aim of the author, who may be either a member of the organization concerned or an outside consultant, is to bring his knowledge to bear directly upon the problem in hand and to determine whether further study is justified by the facts. A report of this kind usually covers the following topics:

1. A statement of the factors dominating the situation as they appear to the author of the report
2. An abstract of developments elsewhere that may be used for comparison
3. An exposition of the advantages of the site, type, or plan that seems best adapted to the circumstances
4. An estimate of the costs of location or construction
5. A summary of the author's conclusions

In short, the object of the preliminary report is to decide whether a careful analysis, involving time and expense, is warranted by the facts of the case. The purpose is more than that of a mere reconnaissance intended to chart the course for a detailed study of conditions. Often, indeed, the proposed work follows directly after the acceptance of the report.

A Case History.—The series of reports which precede and keep pace with the construction of an engineering project will serve to illustrate the forms of reports examined in this chapter. These forms are applicable to any type of enterprise. Specific examples are furnished by the activities of the Port of New York Authority in connection with the proposed Raritan Bay Bridge and the Kill van Kull Bridge. The major steps in these undertakings are outlined on the following page.

I. *Program of Preliminary Engineering Work — Raritan Bay Bridge.*

On May 8, 1931, O. H. Ammann, Chief Engineer, having received on April 22, 1931, authorization "to undertake and complete a preliminary survey" of the proposed bridge, drew up in mimeographed form a program for the survey, as limited by "funds and time." This survey was to cover: (1) traffic studies, (2) maps, (3) borings, (4) studies of approaches and highway connections, (5) real estate appraisals, (6) design studies, and (7) cost estimates.

II. *Report of the Advisory Engineer of Design — Raritan Bay Bridge.*

In December, 1931, the first preliminary report, that of L. S. Moiseiff, Advisory Engineer of Design, was submitted to Mr. Ammann and published in mimeographed form. It contained location studies, mapping surveys, borings, geological studies, design studies, approach connections, and total cost estimates. The report, in the form of a 20-page letter, with plates and blueprints as exhibits, became in turn the basis for further study by the Chief Engineer. A similar report was submitted by the Traffic and Revenue Department of the Port Authority. These were the raw materials out of which grew the printed report by Mr. Ammann.

III. *Report on Preliminary Investigation for Proposed Bridge Across Raritan Bay Between Staten Island, New York, and Monmouth County, New Jersey* (January 27, 1932).

The preliminary report contains the findings of the two letter reports, with the addition of conclusions and recommendations. It includes several units:

1. "Letter of Transmittal," embodying 8 conclusions signed jointly by the Commissioners of the Port Authority.
2. "Report of the Chief Engineer—Engineering Studies," signed by O. H. Ammann.
3. "Report of Assistant General Manager—Traffic and Revenue Studies," signed by W. P. Hedden and approved by Billings Wilson.

Mr. Ammann's report, which covers the topics projected in his tentative program, presents the results of the different studies. In addition, there are four plates and an estimate of costs.

Mr. Hedden's report covers the following subjects: scope and method, field clockings, analysis, volume and distribution of traffic, economic practicability of the bridge, future trends of traffic and revenue, and the effect of the bridge on existing crossings. It contains tables, charts, and photographs.

The significant parts of this report, those which illustrate the points stressed in this chapter, are these:

(1)

(*From the Letter of Transmittal*)

In compliance with this authorization [of the legislatures of New York and New Jersey] the Port Authority has undertaken and completed studies and field investigations which enable it to report on the feasibility of such a bridge, both from an engineering and an economic viewpoint. . . .

CONCLUSIONS

The construction of such a bridge across Raritan Bay does not appear to be justified from an economic standpoint under present traffic conditions.

(*From the Report of the Chief Engineer*)

LOCATION STUDIES

Three locations for the bridge across Raritan Bay have been considered in the studies . . . subsurface conditions are practically identical at all three locations. . . . The studies also developed the fact that from the viewpoint of connections with existing and proposed highway arteries, and with respect to approaches, the location from Sequine Point to Union Beach is most desirable.

DESIGN STUDIES

Studies of existing and proposed highway systems in connection with the Raritan Bay Bridge show that a four-lane crossing would have adequate capacity to accommodate present and future traffic. . . .

Preliminary designs were prepared for two of the three crossings. . . . Except for the advantage of the Tottenville-Lawrence Harbor site as to length, all the advantages were found to be with the Sequine Point-Union Beach location. . . . Other considerations such as the advantages of better connections with existing and proposed highway systems outweigh the factor of slight excess cost. . . .

Estimated Cost

Based upon the above preliminary work of investigation and design, an estimate of cost has been prepared. This estimate includes the cost of real estate and financing and makes allowance for interest during construction.

The following is believed to be a conservative estimate of the cost of the proposed Raritan Bay Bridge:

Construction and Initial Equipment for Operation	$11,000,000
Engineering, Administration, and Contingencies	1,300,000
Real Estate	500,000
Interest during Construction and Cost of Financing	1,200,000
Total Estimated Cost of Project	$14,000,000

(*From the Report of the Assistant General Manager*)

Economic Practicability of Raritan Bay Bridge

Taking the traffic estimates of 1931 as a base, the revenue for the proposed Raritan Bay Bridge must be derived from tolls collected from 890,000 vehicles per annum. Assuming a schedule of tolls similar to the single-fares in effect over the Outer-bridge Crossing, the average revenue per vehicle is about 57¢. Applied to 890,000 vehicles per annum, this indicates a revenue of $500,000.

Operating expenses will be approximately $100,000 per annum. This would leave about $400,000 per annum to pay interest and retirements on bonds.

[The next paragraph sums up the financial requirements]:

Gross Revenue (890,000 vehicles at 57c.)		$500,000
Operating Expenses	$100,000	
Interest at 4½%	630,000	
Total Charges First Year		730,000
Deficit First Year		230,000
Average Annual Retirements (6th to 30th Year)		360,000
Total Deficit		$590,000

These extracts indicate clearly the nature and the principal subdivisions of a preliminary report. Its purpose is to determine the "feasibility" of a proposed plan. In view of its studies, the Port Authority was not able to recommend the construction of the Raritan Bay Bridge; and the project was ultimately dropped.

Exercise: A Preliminary Report.—Prepare a preliminary report on a proposed site or design for one of the systems, structures, mechanisms, or machines listed on pages 394-395. Include in it references to all the points mentioned in this chapter.

Character of the Progress Report.—As explained in Chapter 4, the progress report is used widely in both the physical and biological sciences.

From a physical point of view, it is of greatest service in connection with construction or manufacture. After a piece of work, whatever its nature, has been begun, those who are ultimately responsible for the success of the undertaking will wish to learn from time to time of the advancement which is being made. The communications intended to provide them with this information are known as "progress reports." These reports are really histories of what has occurred (1) since the inception of an enterprise or (2) during a limited period. Although the arrangement is generally chronological, they follow an order not duplicated in any other type of narrative. Because of their function, they point both backward and forward, covering past and present and prognosticating for the future; that is, the writers of such reports tell what they planned to do, what they have done to the date of writing, with due reference to obstacles and hindrances overcome, and what they hope to do in the future. If it seems advisable they may note special activities, changes of plans, and new proposals. As will be seen from the example on pages 163-168, the material is usually arranged in a definite sequence, determined by the order in which the work is being prosecuted.

Progress reports in the biological sciences do not differ greatly in plan. Those dealing with botanical or zoölogical development are often highly significant. These reports are histories, not of what the writers have done, but of what they have seen. Consequently, accuracy in observation is even more important than skill in arrangement. Since the sequence in reports of this character, those treating changes in plants or animals, is strictly chronological, the form is exactly the same as that adopted in any other narrative of fact. It presents no special difficulty.

Another Case History.—To continue the case history, it is necessary to consider another project of the Port Authority, the Kill Van Kull Bridge. The preliminary report for this bridge, submitted on February 1, 1927, was favorable to the undertaking. In the words of the chief engineer, Mr. Ammann: "The traffic studies reveal an urgent necessity for improvement in the transportation facilities between Bayonne and Staten Island. The only adequate and unquestionably the best solution for vehicular traffic is the construction of a bridge." As a result, work was begun in due course; and the Port Authority was kept informed of the state of construction by means of reports of progress, which have come to be known as "progress reports." A consideration of the form is therefore appropriate at this point.

Preparing the Progress Report.—The progress report is similar in many respects to the information report. Material in it is usually drawn from daily and weekly record reports on the project. The record report as a type may be illustrated by the following extracts from the mimeographed "Status of Activities—Week Ending May 25, 1935" of the Port Authority. The section devoted to the Midtown Hudson Tunnel consists of the following subdivisions: contract work, other engineering work, conference and negotiations.

(2)

CONTRACT M H T-4—SHIELD DRIVEN TUNNEL AND SHAFTS
Approximately 52% completed

New York—advancing shield and erecting tunnel lining. Shield now entirely in soft ground consisting of from 1 to 6 ft. of fill overlying Hudson River silt. The shield was advanced 40 ft. during the week, making a total of 717 ft. to date. Shield is now about 61 ft. west of the east building line of Twelfth Avenue. Air pressure of 24 lb. per sq. in. maintained. . . .

Average number of men employed this week—618; to date—432.

When sufficient progress has been made, it is customary to issue progress reports which combine in more permanent form the material collected through the record reports. For instance,

to return to the case history: In April, 1930, the Port Authority issued the *First Progress Report on Kill Van Kull Bridge,* which contains the subdivisions indicated below. In each of the appropriate sections the progress from the beginning to the date of writing, April 15, 1930, is traced as simply and as briefly as possible. Unusual features of the work are also considered.

Letter of Transmittal from the Chief Executive Officer, J. E. Ramsey

Report [in letter form] from O. H. Ammann

1. Introduction giving historical data
2. Location and general description
   - A. Location
   - B. General Design
   - C. Traffic Capacity
   - D. Clearances
   - E. Selection of Arch Design
   - F. Bayonne Approach Plan
   - G. Port Richmond Approach Plan
   - H. Cost Estimates
3. Construction Work
   - A. Contracts to Date
   - B. Test Pits and Borings
   - C. Construction of Arch Abutments
   - D. Steelwork for Arch Span and Approaches
   - E. Approach Piers
4. Research and Special Tests
   - A. Test Model of Arch Span
   - B. Special Column Tests

The report is illustrated with 28 photographs showing the state of construction on various dates, 3 maps and plans, and an interesting graphical presentation of construction progress which is reproduced on page 167.

A typical section from the report will illustrate the procedure to be followed in preparing a progress report. The technique requires little elucidation.

From *Kill Van Kull Bridge, First Progress Report,* Report by The Chief Engineer of Bridges:

(3) April 1, 1930

Mr. J. E. Ramsey, Chief Executive Officer

Dear Sir:

Preliminary engineering studies and surveys for the Kill van Kull Bridge between Bayonne, New Jersey, and Port Richmond, Staten Island, New York, were begun in April, 1926, in accordance with Chapter 97 of the Laws of New Jersey, 1925, and Chapter 279 of the Laws of New York, 1926, which authorized and empowered The Port of New York Authority, in partial effectuation of the Comprehensive Plan for the development of the Port, to construct, operate, maintain, and own the proposed bridge, with the necessary approaches.

By Act of Congress approved March 2, 1925, the Port Authority was authorized to build and operate the bridge.

On February 1, 1927, a report was rendered on the preliminary studies, with tentative recommendations as to the feasibility of the project, the general location and size, and the approximate cost.

During the remainder of 1927, the preliminary work of design and planning for construction was continued, comprising additional traffic studies, topographical surveys, investigation of subsurface conditions by borings and test pits, revision of design studies and cost estimates, and architectural studies. Conferences were held with representatives of the respective municipalities with a view to securing their coöperation and eventual approval of the approach plans.

By the latter part of 1927, the preliminary work had progressed sufficiently to enable definite conclusions to be drawn as to the economic practicability of the project, the most suitable location, the type and general proportions of the bridge, and to permit steps to be taken toward financing of the project.

In November, 1927, application was made to the War Department for approval of the plans. A public hearing was held at the office of the United States Engineer for the Second District, on November 30, 1927, and the application was approved December 31, 1927, by the Chief of Engineers and the Secretary of War.

Financing of the project was effected by the sale on January 5, 1928, of Twelve Million Dollars of Port of New York Authority Four percent Gold Bonds, which, together with Four Million Dollars in authorized advances of the States of New Jersey and New York, furnished the funds for construction of the bridge for initial capacity.

Immediately thereafter further intensive study was given to the elaboration of the most suitable and economical design for the bridge and approaches and to the preparation of detailed contract drawings.

The plans for the approaches and highway connections to the bridge have been developed in coöperation with representatives of the City of New York, the City of Bayonne, The Hudson County Boulevard Commission, Hudson County, Jersey City, and the New Jersey State Highway Department.

The first construction contract was awarded in July, 1928. Since that date construction work to the amount of $6,260,000 has been contracted for, and practically all of the needed property has been acquired.

The work contracted for has included the building of the abutments for the main arch span, the construction of the sub-structures for the approaches, and the fabrication and erection of the steel for the main structure and the approaches. The arch abutments and the approach piers have been completed; fabrication of the structural steel has proceeded rapidly; the erection of the main arch structure is well under way; and erection of approach steel on the Bayonne side has been practically completed.

It is confidently expected that the bridge will be completed ready for traffic in the early part of 1932. . . .

Steelwork for Arch Span and Approaches

A contract for the fabrication and erection of the structural steel for the arch span and for the approaches was advertised in September, 1928, and bids were received November 19, 1928. Three proposals were received, and the contract was awarded November 21, 1928, to the American Bridge Company, the low bidder.

The arch span, as noted previously, is a parabolic two-hinged steel arch. The bottom chord is the principal arch member. . . . It is composed entirely of carbon-manganese steel, and has a cross sectional area of 980 square inches at the abutments, and 580 square inches at the crown. The hinges are formed by pins 16 inches in diameter, bearing upon heavy steel forgings which insure uniform bearing over the supporting structural steel webs. The arch shoes upon which the lower pin bearings are erected are of riveted structural steel. Each shoe is 10 feet high and 15 feet by 18 feet at the base and weighs about 120 tons. Each of the forged pin bearings weighs about 60 tons. The top chords of the trusses are of silicon steel, with cross sections varying from 272 square inches to

421.5 square inches, the greater maximum section being determined by the erection stresses and being 38.5 square inches greater than that required for the arch alone. The web members of the trusses and the bracing between the trusses are of carbon steel. The floor beams and stringers which support the deck slabs are partly of silicon and partly of carbon steel.

The arch is designed to act as a three-hinged arch under the dead load of the trusses and the bracing between them, and as a two-hinged arch for the remaining dead load and the live load. In order to obtain the three-hinged condition, a temporary pin connection will be made at one point on the lower chord of each truss, to act as a hinge until the arch has been swung free of the temporary supports. The arch design is based upon having this hinge at the crown of the arch. However, because of the necessity of keeping the navigation channel, which is close to the Port Richmond shore, free of falsework, unsymmetrical erection is necessary; and the temporary hinge will be at a point 248 feet south of the crown of the arch.

The arch is being erected by cantilevering from each side to the connecting point over the channel. Temporary steel piers, or bents, made up largely of material which will be used later for the bridge deck and the approaches, support the arch trusses at certain points as the erection proceeds. Four such bents are used for the south arm and six for the north arm of the arch. Hydraulic jacks, installed on alternate bents, raise the arch from the preceding bent and then lower it to full bearing on the succeeding bent, as erection proceeds, each bent being wholly unloaded as soon as erection has advanced to the succeeding bent. The hydraulic jacks used by the contractor were manufactured for and originally used in the erection of the Hell Gate Bridge. Each jack has a capacity of more than 3,500 tons. The south arm of the arch was erected to the connecting point over the channel before erection of the north arm was commenced, and the falsework bents released from that arm are being used again to support the north arm.

A single erection traveler, which moves on rails along the upper chords of the trusses, is employed for the work. This traveler consists of a silicon steel frame supporting an erection derrick with 70 ft. boom and gasoline engines for operating the derrick. Upon completion of the erection of the south arm of the arch, this traveler was backed off to the abutment and there dismantled and moved across the waterway to the north abutment, where it was again assembled for erection of the north arm.

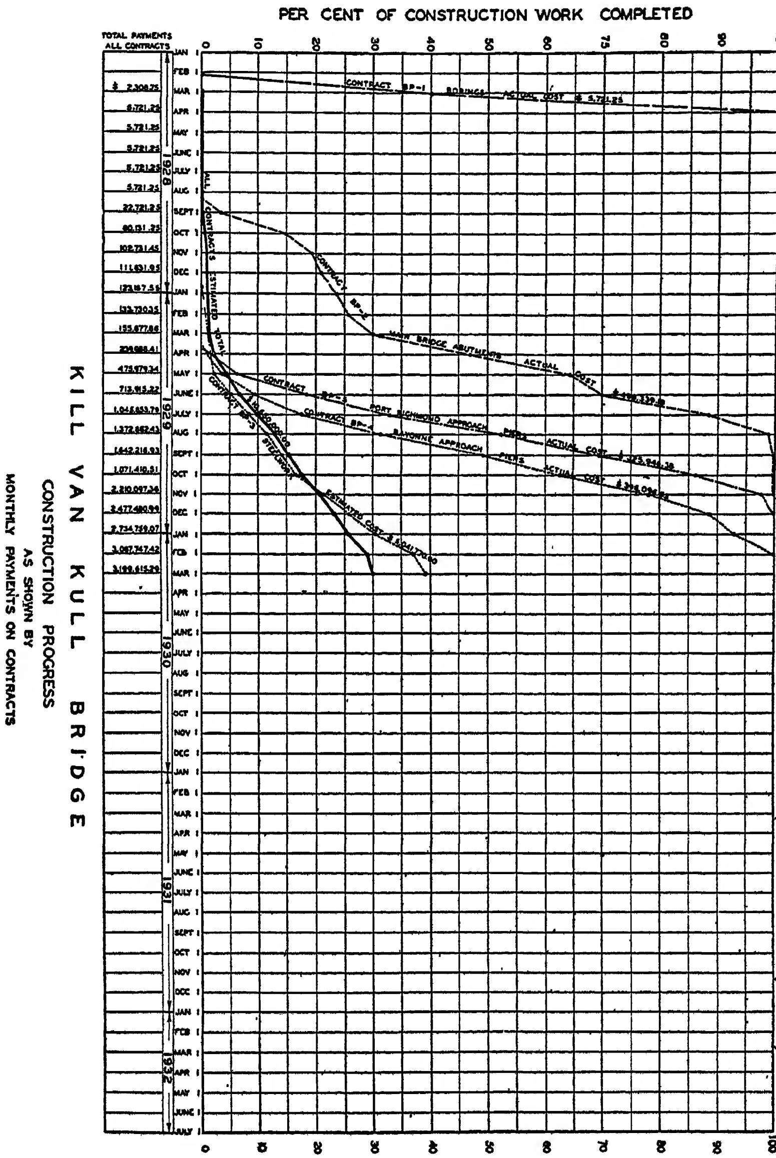


Figure 1. A Graphical Representation of Progress on the Kill Van Kull Bridge
(From *First Progress Report on Kill Van Kull Bridge*, New York, 1930)

After the north arm has been erected, and the hinge connection made to the south arm, the jacks at the remaining bent under each arm will be lowered to swing the arch free of the two bents. It will then be a three-hinged arch, with the third hinge at the fourteenth panel of the south arm. In order to establish the design condition of a hinge at the crown of the arch instead of at this fourteenth panel point, the jacks on the falsework bent beneath the south arm will be raised again to lift the arch a definite amount, which is calculated as the amount needed to remove all stress from the closing chord connection. In this position, the closing connection of the top chords between the two arms will be riveted in place, and the jacks will then be lowered to swing the arch free in its final two-hinged condition.

The approaches consist of a series of deck plate girder spans. The spans vary from 65 to 128 feet in length, and are simple spans, with the exception of one span 183 feet long which comprises the central portion of a three-span continuous girder.

Rolling of structural steel for the bridge was started in April, 1929; fabrication was started in May, 1929; erection was begun in September, 1929; and the erection of the south arm was completed in March, 1930. The arch span contains approximately 16,800 tons of steel, and the approaches contain 9,500 tons.

This excerpt illustrates the general arrangement of progress reports. The material, drawn from field reports or the immediate experience of the writer, is arranged under headings that emphasize the more important aspects of the subject. Particularly worthy of note is the fact that, although the writer does not follow slavishly the sequence of events in the main headings, he does adopt a chronological order in the development of each topic. The result is a number of miniature progress reports, each complete within its own limits. To give a bird's-eye view of development, the report is prefaced with the brief introduction quoted above.

Exercise: A Progress Report to Date of Writing.—Prepare a progress report covering developments since the inception of an attack of influenza; a botanical or zoölogical collection; a brood of chickens; a building fund for a fraternity house; a campaign to raise funds for a student activity; a class book; a chrysalis; a disease among the deciduous trees of a district; an embryo of any kind; an experimental research; a garden plot; an infection in a wheat field; a laboratory

course; an ordinary cold; a reading assignment for a term; an R. O. T. C. unit; a reforestation project; a season in a major sport; a series of bacteriological slides; a summer survey; a tadpole; a term thesis; a building activity of any sort, or a marketing survey.

A Progress Report Covering a Limited Period.—As noted earlier in this discussion, the progress report may be either a history of what has occurred since the inception of an enterprise or of what has taken place during a limited period. When the second type deals with a project directed by someone other than the writer, the arrangement is exactly the same as that followed in the passage above. Within its own limits, this kind of report will assume the form which has just been indicated. Under these circumstances, no special problems are likely to arise. On the other hand, a unique type of progress report has grown out of the annual meetings of the national and international societies whose members are interested in the advancement of their art. In order that they may be aware of the progress made from year to year, they are accustomed to receive from their standing committees reports covering important developments within the scope of these committees. Similarly, the great foundations devoted to research projects and the graduate schools of universities often publish periodically reports covering work in progress in the fields of their interests. Examination of such reports, printed in the proceedings and transactions of the societies or in the bulletins issued by foundations and universities, shows that they differ only in the material treated, and not in the method adopted, from the other type of progress report; that is, they emphasize accomplishments in the light of what has been proposed and outline plans for the future.

The *Report of the Committee on Power Generation,* J. R. Baker, Chairman, of the American Institute of Electrical Engineers, published in *Transactions* of the Society for 1933, is a good illustration of the second type of progress report. Selections from it will show the method used.

The *Report* is introduced by a general statement emphasizing notable achievements in the field, as indicated by the quotations:

(4)

Following the intention announced in last year's report, the A.I.E.E. committee on power generation continued to promote the discussion of matters in the field of electric power generation from a retrospective and generally analytical viewpoint, for the particular purpose of weighing recent tendencies in design to the end that profitable avenues of progress may be revealed and utilized when capital investment again is resumed on a hitherto normal scale in the construction of power-generating facilities. The committee does not believe that the present lull in construction activities should result in a stagnation of the directive thought that will be responsible for the design of power stations in the future, nor in the entire diversion of such ability to the problems of minor improvements and operation under reduced output, commendable and necessary as such duties may be. It is glad to report a very real interest among responsible engineers in the consideration of the major principles governing the economic generation of power, and to note that fundamental thought and work are being actively continued.

The committee calls attention in this report to 4 papers presented at the 1932 A.I.E.E. summer convention, Cleveland, Ohio, that discuss current practices in the operation of power systems which include several generating plants. The success in the operating interconnection among a group of plants to supply a load area has been one of the notable achievements in the last decade in the field of power generation. These 4 papers summarize present ideas about the most effective methods of operating such systems to obtain maximum reliability in service and minimum operating cost. They also indicate a reduction in operating expenses on representative power-generating systems in the immediate past and give assurance that the improvement in operating economy has not been at the expense of unjustified carrying charges. . . .

A subcommittee under the chairmanship of F. H. Hollister has in preparation a symposium on the subject "Switching Energy at Modern High-Capacity Generating Plants," which is contemplated for presentation at the 1934 A.I.E.E. winter convention. Experience during the more recent years where particular generator, bus, and switching arrangements are used, will be analyzed, the limitations discussed, and the probable trends noted.

The committee recommends also that the subject of regenerative hydroelectric plants presents opportunity for the assembly of valuable experience derived in European plants. The use of this type

of plant has been more extensive in Europe than in this country, but some engineers believe that the future will witness an increasing number of such plants in the United States.

The custom of the committee has been to prepare a detailed progress report and bibliography in its field at biennial intervals; the remainder of this report therefore summarizes matters of interest that have developed or culminated in the past 2 years.

Following the general statement, seven sections survey progress in the various fields of power generation:

1. Volume of Power Generation
2. Generating Plant Construction Progress
3. Interconnection
4. Steam Plant Practice in the United States
5. Oil and Gas Power
6. Foreign Steam Plant Developments
7. Developments in Hydroelectric Practice

V. Oil and Gas Power

Several progressive features are evidenced in the Diesel engine field, such as reduction in weight, use of trunk pistons of large diameter, and increased speed. The increased use of alloy steels is noticeable, also the discontinuance of air injection in favor of mechanical injection. The trend in small plants is largely to the use of the single-acting 2-cycle engine.

The City of Vernon (California) Power Plant will contain 5 7,000-hp double-acting 2-cycle engines and will form the world's largest Diesel-electric power plant. Each engine has 8 cylinders 24 in. by 36 in., runs at 167 rpm, and will drive a 5,000-kw generator.

The Lamoka (New York) combination gas-electric hydroelectric and pumped-storage plant of the Lamoka Power Corporation is unique. The installation consists of a 2,000-hp vertical-shaft hydraulic turbine in operation, and a 7,500-hp turbine under construction. The turbines operate under a net head of 385 ft. One vertical 1,200-hp 6-cylinder 4-cycle gas engine drives an 800-kw a-c generator, and each of 3 1,800-hp engines drives a 1,250-kw generator. Each 1,800-hp unit consists of 2 6-cylinder engines with the generator and flywheel between. These engines are the largest of their kind in this country. During off-peak periods, the gas engine driven generators supply power to pump water into the hydro-plant reservoir by means of one 8,000-gpm

and 2 16,000-gpm motor-driven pumps. Natural gas is brought from wells 1,750 ft under the land owned by the power company; it is probable that this is the only combination gas and water power plant using these 2 resources from the same land.

VII. Developments in Hydroelectric Practice

Progress in hydroelectric practice during the past 2 years was foretold to a large extent in the 1931 report of this committee, when the impending developments in the use of the Kaplan turbine in this country were discussed. Other than this significant step there does not appear to be any distinctive innovations of major importance in the designs of the hydroelectric projects placed in operation during the past 2 years. The probable future trend, if any, with regard to the type of propeller turbine that may be preferred for low head plants, however, is not yet clear. The Kaplan, or automatically adjusted-blade turbine, was installed in the Safe Harbor Plant on the Susquehanna River in Pennsylvania; manually adjusted-blade turbines in the Rock Island Plant on the Columbia River in Washington; and fixed-blade turbines in the Chats Falls Plant on the Ottawa River in Canada. These plants are typical examples of the most recent use of propeller turbines for low head developments. A very interesting high head development was placed in service on the Mokelumne River in California. The Ariel Plant on the Lewis River, Washington, and the Wyman Dam development on the Kennebec River, Maine, were representative of medium head designs and display novel ideas in building and superstructure designs.

Interest in cavitation investigations in this country has continued largely as the result of the increasing use of the propeller turbine in low head plants. The first cavitation research laboratory in the United States was recently opened at the Massachusetts Institute of Technology, . . . and there are now several commercial and institutional laboratories equipped for making cavitation tests on model runners. Testing of models of all important structures comprising a hydroelectric development is now accepted practice, and is well exemplified by the extensive model studies made for the Boulder Dam on the Colorado River. The European practice of using multiple current meters distributed over the intake area for the field testing of hydraulic turbines was introduced in the United States at the Safe Harbor plant, where the short length of intake passage was believed to render the commonly used methods of water measurement of doubtful value.

The number of pumped storage developments on this continent is small compared with those in Europe, but the possibility of regenerative pumping at the Safe Harbor plant by means of the dual use of the same unit as a turbine and a pump has been investigated recently. Turbine manufacturers have developed runners suitable for such dual use, and the electrical problems incident to reverse operation at either a similar speed or a dual speed appear possible of ready solution. The limited practice heretofore in this country has been to install a motor driven pump entirely separate from the turbine-generator, although both pump and turbine are connected to the same penstock. The arrangement commonly found in Europe consists of a single electrical element used either as a generator or motor, with a permanently connected turbine on one side and a clutch connected pump on the other.

Discussion of the economics of hydroelectric projects during the past 2 years has been focused on: the determination of the cost characteristics of different types of developments; the relative economy of water power as compared with steam power; the influence that the incremental cost of hydroelectric capacity has upon the size of development; and the peak substitutional value of water power as compared with steam power on the available load curve. The latter 2 factors are of particular importance in the consideration of pumped storage and regenerative installations.

Development of the Mokelumne River in California having a drainage area of 365 square miles over a gross static head of 5,100 ft by means of 4 plants in series on the flow line without appreciable intervening storage, may be the last high head development for some time on the Pacific Coast. The maximum flow used, 650 cfs, is 80 per cent of the average yearly stream flow, which is regulated almost completely by storage reservoirs having a volumetric capacity equal to ⅓ of the volume of run-off. There are 3 impulse installations operating at gross heads of 2,089, 1,265, and 1,219 ft; and 2 Francis wheel installations for heads of 285 and 245 ft. One of the 5 main dams is the largest rock-fill dam in the world, having a height of 328 ft and a crest length of 1,300 ft. The peak capacity of the plant is 144,000 kw. . . .

The Rock Island plant on the Columbia River is the first major low-head run-of-river development on the Pacific Coast and also the first step in the development of the hydroelectric possibilities of the Columbia River. The drainage area above the plant is 90,000 square miles; maximum and minimum recorded flows have been 740,000 and 21,000 cfs, respectively, and the mean flow is

121,000 cfs. The head for the initial installation of 4 21,000-hp units is 32 ft; it will be increased to 48 ft with the addition of more units, of which there ultimately will be 12. Initial full draft water requirements are about 75 per cent of the minimum steady flow, and about 135 per cent of the lowest recorded flow. Because of the low- and varying-head conditions, manually-adjusted-blade propeller wheels were installed; these have a diameter of 223 in. and are the largest propeller wheels on this continent. The plant operates at a capacity use factor of about 90 per cent, which, in comparison with the run-of-river plants in the eastern section of the United States, represents a relatively small capacity installation with respect to the minimum flow capacity.

The Chats Falls plant on the Ottawa River, Canada, is a low head development 53 ft, showing a somewhat greater ratio of installed capacity to regulated flow capacity. The drainage area above the plant is 34,000 square miles, but because of the presence of numerous lakes the minimum dependable flow is now 22,000 cfs. The 8 28,000-hp fixed-blade propeller units require a full draft equal to 2 times the minimum flow. This plant serves a large system that derives its entire supply of electric power from hydroelectric sources.

The Safe Harbor plant on the Susquehanna River is notable for having the highest powered propeller turbines in the world, the units being rated at 42,500 hp under a head of 55 ft. The full draft requirement of the plant initially is about 12 times the minimum regulated flow; the yearly use factor will approximate 50 per cent. The initial installation consists of 6 units, with headworks structures for 6 additional units. The hydraulic and electrical design anticipates the dual use of the units for generation and regenerative pumping; the plant will be the first low head development planned for such operation, which is readily accomplished because the Safe Harbor plant discharges directly into the pond formed by the Holtwood dam 8 miles farther down the river. The electrical layout in the plant provides for: 3-phase 60-cycle, and single-phase 25-cycle generation; 60-cycle low voltage busses; and control of transformers placed above the bus galleries for stepping up to 69 and 230 kv for transmission. The 25-cycle generators will be the largest single phase waterwheel units in the country, having a rating of 37,500 kva at 80 per cent power factor. High voltage switch yards for the control of outgoing 60- and 25-cycle transmission lines will be placed on shore adjacent to the power house. Outdoor frequency changers rated at 25,000 kw,

80 per cent power factor, will be installed below the bulkhead connecting the power house with the shore.

The Ariel and Wyman Dam plants exhibit an interesting treatment of superstructure design, which in both plants consists of a low roof with removable hatches over the generators. Outdoor 2-leg gantry cranes serve the generator areas; that at the Ariel plant is the largest outdoor power house crane yet built, having a span of 67 ft, a lift of 80 ft above crane rails, and a capacity of 350 tons. The Ariel plant is notable also for having the largest overhung generator with revolving field installed to date; it is rated 56,250 kva at 80 per cent power factor, 120 rpm. Other novel features of the Ariel plant are the location of a part of the power house upon a concrete arch spanning a deep gut in the foundation rock, and the location of the control room in an adjacent but separate building. The drainage area above the Ariel plant is 733 square miles. One 55,000-hp 170-ft-head unit has been installed initially; the complete plant will contain 4 units with the expectation of using seasonal storage for low use-factor operation. The Wyman Dam plant has an initial installation of two 34,000-hp 135-ft-head units, with provision for a third unit in the future. The use factor of this plant will be of the order of 45 per cent.

Records for maximum size and extreme conditions of installation of propeller turbines continue to remain with European plants. Among the more notable are the following Kaplan installations:

Plant	Horsepower	Head, Ft	Runner Diam, In.	Discharge Cfs	Speed Rpm
Vargon, Sweden.....	15,000	14	315	11,090	46.9
Swir, Russia.........	37,500	36.1	292	10,240	75
Shannon, Ireland....	33,000	106*	161	3,040	167[1]

* Head initially is 82.25 ft.

In view of the fact that a report of this nature ordinarily covers a year, which is the recognized administrative unit, it is often confused with the periodic report. There is no other reason for the confusion. The essence of any periodic report—that which distinguishes it from every other type—is the series of contrasts on which it is based. No argument is necessary to show that, in a progress report, comparison of this kind is relatively unimportant. The aim of the committee of the American Institute of Electrical Engineers was merely to ex-

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plain the progress of development and to indicate the results attained in the course of a biennium. Its report is fundamentally historical.

In the following sections from the "Report of the Subcommittee on Airships," *Twentieth Annual Report of the National Advisory Committee for Aeronautics* (Washington, D. C., 1934), the other two aspects of the progress report, review of proposals and anticipation of developments, receive more attention:

(5)

LANDING GEARS.—The results of the investigation of the drag of airplane landing gears completed last year have been issued as *Technical Report* Number 485. Despite the wide selection of wheels, strut arrangements, and fairings tested in the original program, a large number of requests for further information were received from manufacturers and from the military services. A supplementary program was therefore carried out. This program was in two parts, the first covering retractable and partly retracted gears for use on low-wing transport airplanes, the results of which have been given in a technical report now being printed, and the second, a further study of landing gears for smaller airplanes. The results of the entire program are now being prepared for publication.

The tests have shown that the drag of partly retracted landing gears can be reduced to low values by suitable fairing, and that the streamline wheel which gave indifferent results in the original tests can be used to advantage if the interference is reduced by proper arrangement of struts and fairings. It may also be said that a fixed landing gear will have a low drag if properly arranged, the principal requirement being that the interference between parts be kept low, this interference constituting a large part of the total drag. Several landing gears of practicable form meeting these requirements were developed in the course of the tests.

ROTATING-WING AIRCRAFT.—Considerable effort has been devoted during the past year to a continuance of the theoretical and experimental work on rotating wings, for the principal reason that they are believed to constitute one of the best existing solutions to the problem of safe, stable, and controllable low-speed flight. . . .

A systematic investigation of the influence of the fundamental parameters of the autogiro rotor has been started in the propeller-

research tunnel with tests on a series of model rotors of 10-foot diameter differing only in airfoil section and plan form. Measurements of air forces and moments and the rotor-blade motion are being made at several pitch angles over the entire angle-of-attack range of each rotor. The work is at present only partly completed, but it has been established that the airfoil section of the blade has a critical influence on the maximum pitch setting at which autorotation is obtained. It is expected that the results of these tests will be applicable to the gyroplane as well as the autogiro.

Flight tests on the autogiro disclosed that at high air speeds the rotor speed decreased dangerously and limited the safe high speed of the machine. A study of the load distribution between rotor and fixed wing indicated that this phenomenon might be caused by a transfer of load from rotor to wing at high speeds. Flight tests were consequently made with the fixed wing set successively to lower incidences, and measurements of the rotor speed and wing pressure distribution were made. The results confirmed the original hypothesis and showed that by a suitable choice of wing incidence the rotor speed could be made to increase at high speed instead of decrease. The results of these tests are being prepared for publication. . . .

A model cyclogiro rotor, 8 feet in diameter and 8 feet in span, was built and tested in the propeller-research tunnel. Power input, lift, and drag were measured over the entire operating range of the rotor from conditions approximating hovering flight to those simulating high speed. The power required by the rotor, was, in general, found to be disappointingly large, being about twice the predicted value for the blades after the tare power for the shaft and supports had been deducted. The results were such that it is now thought that the cyclogiro has very limited possibilities. The information obtained in the wind tunnel is being prepared for publication.

Analysis of the latter section makes clear the reason for continuation of the work, both theoretical and experimental, on rotating wing craft. The next two paragraphs (omitted here) show how theories have been subjected to practice in test-flights and wind-tunnel experiments. The following paragraph (quoted above) shows that studies on the rotor-pitch and airfoil section are already yielding enough results to justify further experimentation; and the final paragraph indicates that

the committee is ready to predict a limited sphere of usefulness for the cyclogiro. Thus the past, the present, and the future all receive attention in the report of the committee.

As these excerpts indicate, the progress report covering a limited period does not differ materially from the other type. In both types, there are proposals to be reviewed, results to be interpreted, and anticipations to be discussed.

Exercise: A Progress Report Covering a Limited Period.—Prepare a progress report reviewing the activities of one of the following organizations during the course of the year:

An athletic association; a baseball or football team; a class; a cosmopolitan, debating, dramatic, press, scholarship, or territorial club; a college orchestra; a coöperative store; a fraternity; a literary, musical, philanthropic, religious, or literary society; a union; a university band.

Parallelism for Emphasis.—It is evident that in any progress report there is necessarily some discrepancy, or difference, between proposals and results; between the things which the writers expected to do and those which they actually did. Naturally, therefore, a form likely to accentuate this difference has been developed. Arrangement is often parallel; that is, plans are recapitulated in one column and achievements in another directly opposite. As a rule, sections are numbered consecutively. The advantage of this scheme, now commonly employed by boards of trade and chambers of commerce, is that it throws into relief developments during the period covered by the report. Where these are accentuated by one of the graphic devices described in Chapter 7, the arrangement is peculiarly effective.

Statistics in the Progress Report.—As in the information report, statistics are generally employed to illustrate tendencies. They may be presented by any of the methods—tabular, graphic, or literal—described in Chapter 7. One interesting technique is that used by the Port of New York Authority and illustrated in Figure 1 from the *First Progress Report of the Kill Van Kull Bridge*. This chart shows at a glance the status of each portion of the bridge; that is, the percentage of each contract completed, the date of its completion, the actual and estimated cost, the total amount of money expended to date,

and the anticipated date of completion of the structure. It is a graphic summary of the progress report itself.

In a further example, *A Progress Report of the Results Secured in Treating Pure White Pine Stands on Experimental Plots at Reeve, New Hampshire,* Yale School of Forestry Bulletin 7 (1922), by the late Ralph C. Hawley, Professor of Forestry in Yale University, there are sixteen tables, occupying half the space in the report, devoted to summaries of conditions at the beginning and the end of a fifteen-year period. By means of these tables it is possible to establish the facts regarding thinned and unthinned areas. The increase in the height and diameter and in the board and cubic feet of the trees on any plot can thus be determined without difficulty. After being determined in this manner, the growth can be analyzed and discussed in independent paragraphs. Similarly, in many of the progress reports in the *Proceedings* of the American Railway Engineering Association, the statistics on the economies of railway, operation, on track, structures, and on buildings, are interpreted by means of tables, charts, and comments. As a rule, all three methods may be used to advantage, although, in some cases, one of them may be especially effective. Charts, for example, are sometimes employed exclusively in interpreting the advance on a construction project.

Preparing the Final Report.—The third type of special information report is the final report, prepared when it is advisable to preserve a permanent record describing a completed project. It is closely connected with the preliminary and progress reports already discussed, and often, when the preliminary report has led to more detailed studies of operation or design, with the operation and construction reports considered in Chapters 14, 15 and 16. Since it usually deals with the success of the design suggested, it is especially related to construction reports.

Its aim is to show how the plans proposed have been realized. Under these circumstances, the text will necessarily include references to the conditions which led to the enterprise; to the factors governing the design; to the technical considerations involved; to the methods of construction employed, and to the materials and costs. Moreover, since a report of this character

is a kind of personal accounting, or, at least, as the letter by Messrs. Harrington and Howard quoted in Chapter 1 indicates, a justification of the responsibility accepted by the engineer or architect, it invariably includes a comparison between recommendations and results. An important element is the description of the completed system, structure, mechanism, or machine.

The essential content of the report may be summarized as follows:

I. History of the project

II. Design and construction data
   1. General and local factors
   2. Common and unique methods

III. Results, described and illustrated

IV. Cost, compared with estimates
   1. Labor
   2. Material

Although there is no definite order in which these details are presented, the main divisions seldom vary.

A Typical Final Report.—To continue the case history of bridge construction as a means of illustrating special information reports, it may be well to examine a typical final report, *The Bridge over the Delaware River Connecting Philadelphia, Pennsylvania, and Camden, New Jersey* (Philadelphia, 1927), by Ralph Modjeski. Like most reports of the kind, it is addressed to laymen; and it is therefore cast in a distinctly popular mold. A permanently bound volume of 157 pages, 12 x 20 inches in size, with 24 additional plates, it preserves not only an account of the construction of the bridge in the body of the text but also a complete technical exposition of the problems of design and construction in the six appendices. As is often the case, it therefore assumes the form of a double report, the first part popular, the second technical.

A simplified table of contents will indicate how this report, although perhaps more elaborate than the norm, does not in other respects vary from the scheme suggested in the last paragraph:

Historical and General Narrative
- Early Projects
- Creation Delaware River Bridge Joint Commission
- Work Begun, 1922
- Bridge Completed and Opened, 1926
- Vehicular Traffic

Design
- Location of Bridge and General Arrangement
- Cross Section
- Design Loading
- Main Pier
- Anchorages
- Main Towers
- Cables
- Stiffening Trusses
- Floor . . .
- Approaches . . .

Construction
- Main Piers
- Anchorages
- Main Towers . . .

Mill and Shopwork
- Main Towers
- Anchorage Cable Bents
- Cables
- Suspended Structure

Appendices
- A. Personnel
- B. Principal Dimensions and Quantities
- C. Contracts and Cost, Summary of Cost
- D. Design
  - Deflection Theory
  - Anchorage Foundations
  - Cable Calculations (Method of Successive Approximations)
  - Analysis Unbraced Top Chord
- E. Abstracts from Specifications . . .

F. Tests

Individual Wires . . .

Cable Bending . . .

Grating

Web Plate Compression

Carbon, Silicon and Nickel Steel . . .

Roadway Slabs . . .

The report is profusely illustrated with over 150 photographs and over 100 figures, charts, drawings, and diagrams. The photographs, often camera studies of artistic value, carry the story of construction from the beginning to the end and form a striking supplement to the written record. The whole report is a worthy memorial of a great undertaking. The diagrams and charts present graphically many of the problems solved by the engineers; and the supplements set forth the actual engineering data, calculations, and tests. Finally, a magnificent series of plates presents the actual working drawings of the structure. As a result, the report has become a source book for advanced studies in bridge design. Although such completeness is seldom found in final reports, the care of the compilers has been justified in the beauty and usefulness of the record.

The style of a final report, as will be seen from the following selections, offers no special obstacles. It is direct narrative, description, and exposition.

(6)

(*From Historical and General Narrative*)

On July 20, 1923, a contract for the anchorage cable bents was awarded to the American Bridge Company at $376,590.00. Bids were received for the main cables on August 15 but had to be rejected as they exceeded the balance of available funds, which at that time amounted to but $2,823,000. On August 29 the Commission approved the suggestion of the Board of Engineers that bids be called for on a modified form of contract, the principal change being the elimination of the cable band castings and suspenders, which could be contracted for separately, at a later date, without holding up the progress of the work. A contract,

on this revised basis, was awarded to the Keystone State Construction Company on September 21, 1923, at $2,546,900.

At the November, 1923, election the voters of Philadelphia approved a bond issue of $6,423,000, which, after refunding the $800,000 borrowed from current funds in June, left $5,623,000 for additional bridge contracts and purchase of land. The Joint Commission had now received the entire sum required under the original estimate to complete the bridge and was able to proceed at once with the acquirement of all real estate and the letting of the contracts for the suspended spans and the approaches. . . .

(*From Section on Design*)

The nearest precedent to such a roadway, on a long span bridge, is that of the Queensboro Bridge, where the distance between curbs is 53 feet, 2½ inches. Our observations showed that width to be not quite adequate for six lines of modern traffic, and a lane width of 9 feet 6 inches was decided upon, giving 57 feet between curbs. This has proved very satisfactory in service and has all the flexibility that had been hoped for. At rush hours, four lines of traffic have been run in one direction and two in the other, giving a marked increase in the capacity of the bridge in the direction in which the movement is heaviest. . . .

In arranging for surface car and high speed lines, sufficient clearance has been provided to allow for wider cars. A nine-foot width of street cars on the inner tracks and a train of ten feet width of high speed cars on the outer tracks can comfortably be operated within the available clearances. . . .

(*From Section on Construction*)

Splicing and Reeling the Wire.—Splicing and reeling the wire at the site was an innovation in cable construction. The wire was shipped to the site in coils containing about 3,000 feet and weighing about 300 pounds. As the coils were received they were stacked and stored in a large shed which was available near the Camden anchorage. The reeling plant was set up in this shed, and here the coils of the wire were spliced and wound on reels in 15 mile lengths weighing approximately 8,000 pounds.

The advantage of performing this operation at the bridge site was that it permitted the storage of a large quantity of wire in the field before cable spinning began and eliminated the delay and expense incident to shipping empty and loaded reels between the wire mill and the bridge.

The wire was spliced with a small ferrule or closed turnbuckle generally similar to that used on previous wire cable suspension bridges. The ends of the wires were threaded by cold swedging at the field splicing plant and the ends beveled at an angle of about 45 degrees. The ends to be joined were threaded opposite hand, the ferrules having corresponding right and left hand internal threads, overlapping for a short distance in the center. The threaded ends of the wires to be spliced were held in special vises so arranged that as the ferrule was rotated the two ends of the wires were drawn together until the beveled ends mitered. The right and left hand threads and mitered ends operated to prevent a wire from untwisting from the splice during the operation of wire stringing. Two machines, one for right hand and one for left hand threads, threaded sufficient wire to serve the four reeling machines. The plant was operated 24 hours a day to keep never less than one day's supply of reeled wire ahead of the spinning operation.

A test slice was taken from each reel and tested to destruction in a machine nearby. The splice tests were all within the specifications, which called for the splice to develop·95% of the strength of the wire. In many cases the splice had a higher strength than the two ends of wire which had been spliced. Inspectors were on duty in the reeling plant at all times to witness the splicing and to condemn wire that became kinked or wavy during the operation. The inspector also witnessed and certified the weight of wire on all reels before they were delivered to the site for spinning. The reeling plant started operation on June 3, 1924, and completed its work on January 16, 1925.

Appendix B—Principal Dimensions and Quantities

General Dimensions

Total Length of Bridge and Approaches	9,570 feet
Length of Main Span	1,750 feet
Width of Bridge	128 feet
Width of Roadway Between Curbs	57 feet
Height of Towers Above Water	380 feet
Clearance of Bridge Above Mean High Water	135 feet
Weight of Main Span Per Linear Foot	26,000 pounds
Live Load Capacity Per Linear Foot	12,000 pounds
Total Weight of Bridge	720,000 tons
Deepest Foundation Below Mean High Water	105 feet

CABLES

Diameter of Cables		30 inches
Number of Wires in Each Cable		18,666
Size of Wire	No. 6	0.195 inch diam.
Total Length of Wire Used		25,100 miles
Weight of Cables		7,000 tons

	Granite	Concrete	Total Masonry
Main Piers	6,600 cu. yds.	52,400 cu. yds.	59,000 cu. yds.
Anchorages	14,000 cu. yds.	202,000 cu. yds.	216,000 cu. yds.
Approaches	4,600 cu. yds.	35,400 cu. yds.	40,000 cu. yds.
Total	25,200 cu. yds.	289,800 cu. yds.	315,000 cu. yds.

PAVING

Roadway	50,000 sq. yds.
Footwalks	20,000 sq. yds.

STRUCTURAL STEEL

Main Towers	10,000 tons
Suspended Structure	18,600 tons
Anchorages	7,300 tons
Approaches	25,800 tons
Total	61,700 tons

The final report is often summarized in a small brochure, attractively bound in art covers, which serves as a souvenir of the opening ceremonies and as a concise record of the project. The material contained in the souvenir of the dedication of the Bayonne, or Kill Van Kull, Bridge, for instance, consists of a striking photograph of the bridge partially finished, an architect's drawing of the completed structure, the program of dedication, 2 pages of historical background and financial facts, 2 pages of statistical data about the bridge itself, and 3 pages of personnel connected with the design and construction. Often, when the progress reports of an undertaking have been especially complete, such a booklet constitutes the final report prepared for publication.

Exercise: A Final Report.—Assume that one of the systems or structures mentioned on pages 394-395 has been completed. Prepare the final report required under such circumstances.

CHAPTER 9

EXAMINATION REPORTS—PRELIMINARY CONSIDERATIONS

Purpose of the Examination Report.—The examination report is similar in many respects to the information report. In both instances, the purpose is the accumulation of a body of facts which may be used as a guide by those responsible for action. In one respect, however, the examination report differs materially from the other type. Since the author, at the outset, is unfamiliar with the facts desired, he must make himself acquainted with them; and this necessity influences perceptibly the character of the report.

Kind of Subject Treated.—The examination report deals with every conceivable kind of material. There is no phase of life, animate or inanimate, that is not at some time subjected to examination. Nothing exists, nothing has existed, nothing is being done, nothing has been done that is not of sufficient interest, public or private, to warrant a study of its significance. Such a study may be merely an hour's test of a dynamo by a student in a college laboratory or a day's exploration of a neighboring pond. On the other hand, it may be as extensive, as prolonged, and as varied as the investigation of the President's Committee on Social Trends or the survey of the St. Lawrence Waterway by the officials of the International Joint Commission, a survey that reached from New York and Boston, in the East, to Boise and Calgary, in the West; that extended from March, 1920, to January, 1922, and that depended upon the collaboration of numerous groups in all parts of the territory affected. While it is impossible to classify with any degree of accuracy the topics treated in the same way, they fall generally under the three categories—materials, processes, and persons—mentioned in Chapter 4. As a result, a

writer is concerned with such matters as composition, economy, and efficiency. The ultimate aim, from an executive point of view, which is ordinarily that of the reader, is to establish the character of certain substances or procedures, to secure the maximum return from the routine of manufacture or merchandising, or to obtain the highest possible service from the members of an organization. Consequently, the examination report may be a report by a mineralogist upon an assay, a report by an engineer upon the routine in a factory, or a report by an efficiency expert upon personnel. It may deal with any field of business, finance, education, sociology, or government. Whatever the subject, the problems which arise and the ways in which they may be solved are essentially the same. The function of this chapter and of the three chapters which follow it is to explain some of these difficulties and to outline the methods by which they may be overcome.

Characteristics Needed for Success.—The qualities of the examination report are those which have been stressed in connection with the report as a type in literature; that is, completeness, clearness, and conciseness. In addition to these qualities, which reflect indirectly the temperament of the writer, it possesses others, such as truth and proportion, which are directly personal. Success depends upon accuracy of observation and correctness of emphasis. The author must be able to see things as they are and to discriminate between the important and the unimportant. Although Shaw's remark that only one man in a hundred can view the world without a squint may not be true physically, it is undoubtedly true intellectually. Heredity and environment are powerful deflectors. In their well-known *Report* for the National Electric Light Association, W. S. Murray and Henry Flood, Jr., insist that government ownership and control in Ontario has been a failure. On the other hand, the Hydroelectric Commission in its *Refutation* (Toronto, 1922) maintains that the data, about which there is no disagreement, establish the efficiency of its enterprises. In each instance, conditions appear in different lights. Although the matters treated in these cases are highly controversial, there are few subjects which an investigator is likely to approach

with an absolutely open mind. Alertness against prejudice is therefore a cardinal virtue. The attitude of the writer of a report should be that of a scientist, thorough in the collection of facts, honest and accurate in recording them, and impartial and unbiased in interpreting them.

Points of View Which May be Adopted.—The dangers of pre-conception can be illustrated by the obstacles which confront the plant manager and the consulting expert, who are usually entrusted with the task of examination. The manager, who is on the inside, and who is therefore familiar with many of the facts to be considered, is apt to overlook the crux of the situation and to miss the point of the investigation. His nearness to his material is a serious handicap. On the other hand, the expert, who is ordinarily from the outside, and who is therefore unfamiliar with the facts, is apt to be dominated by fixed ideas—the results of previous studies—which render him equally blind to matters which are actually significant in the case under examination.

Three Phases in the Procedure.—In the preparation of every report, there are three distinct phases:

1. Formulating the plan
2. Making the examination
3. Writing the report

The formulation of the plan, which includes determination of (a) the aim of the study, (b) the scope of the investigation, and (c) the method of attack, and which is primarily office work, is discussed in this chapter. The other two phases will be discussed in later chapters.

Aim of the Study.—The first step in the preparation of an examination report is the determination of the aim or purpose of the study. Usually it grows out of a series of letters or conferences, or both. Since an expert is usually employed for a specific purpose—to secure data, for instance, regarding the defects in certain structures or the possibilities in certain proposals—the determination of the aim is not likely to cause

delay. In practice, it is usually fixed by the client, who knows the information which he wishes to obtain. Actually, the purpose is established in one of four ways:

1. By a series of questions
2. By an analysis of conditions
3. By a letter of instruction
4. By an agreement as to procedure

The most natural and the most common of these methods is the first, known technically as "a reference." Kipling's keys —When? Where? Why? What?—will unlock most doors of knowledge. When the governments of Canada and the United States wished to come to a decision regarding the proper level for the Lake of the Woods, they submitted to the International Joint Commission the following questions:

(1)

(1) In order to secure the most advantageous use of the waters of the Lake of the Woods and of the waters flowing into and from the Lake on each side of the boundary for domestic and sanitary purposes, for navigation and transportation purposes, for fishing purposes, and for power and irrigation purposes, and also in order to secure the most advantageous use of the shores and harbors of the Lake and of the waters flowing into and from the Lake, is it practicable and desirable to maintain the surface of the Lake during the different seasons of the year at a certain stated level and, if so, at what level?

(2) If a certain stated level is recommended in answer to question No. 1, and if such a level is higher than the normal or natural level of the Lake, to what extent, if at all, would the Lake, when maintained at such a level, overflow the lowlands upon its southern border, or elsewhere on its border, and what is the value of the lands which would be submerged?

(3) In what way or manner, including the construction and operation of dams or other works at the outlets and inlets of the Lake, or in the waters which are directly or indirectly tributary to the Lake, or otherwise, is it possible and advisable to regulate the volume, use, and outflow of the waters of the Lake so as to maintain the level recommended in answer to question 1, and by what means or arrangement can the proper construction and opera-

tion of regulating works, or a system or method of regulation, be best secured and maintained in order to secure the adequate protection and development of all the interests involved on both sides of the boundary, with the least possible damage to all rights and interests, both public and private, which may be affected by maintaining the proposed level?

As in this case, the questions asked are often pyramidal in character, each being dependent upon that which precedes it.

Although a client is usually able to indicate definitely in this way the information which he desires, he is sometimes forced to rely upon the judgment of the expert whom he has consulted. He may know nothing except that a process is uneconomical or that an organization is inefficient. Under these circumstances, he will naturally find it advisable to lay the situation before the specialist whom he has engaged and to accept his counsel regarding the character of the investigation which he has proposed. His position is not unlike that of the patient who tells his physician that he is feeling miserable but does not know what is wrong. Just as the physician proceeds, through conference, to determine the nature of the examination required, so the expert, whose opinion is usually accepted as final, may analyze the situation which is presented to him and determine the aim of the study which he has been asked to undertake. As may be seen by a glance at the following extract from the "Introduction" to the *National Power Survey Interim Report, Power Series* Number 1, of the Federal Power Commission (Washington, D. C., 1935), the expert himself may formulate the questions to be answered:

(2)

One of the primary objectives of the Survey as specifically stated in the Executive Order of President Roosevelt is a determination of the power requirements of the country and a study of the economic relation between water power and power from fuel plants. This is necessary in order that a correct answer can be made to the following questions:

1. What are the present and future power requirements of the continental United States?

2. From what sources can these power requirements be supplied most economically and efficiently in the public interest?

If the expert does not actually formulate a series of questions of this kind, he may analyze the situation and indicate, for the benefit of his client, the aspects which require consideration. When the Bureau of Municipal Research undertook to report upon the advisability of New York City generating electric current in certain of its public buildings instead of buying it, as in the past, from a company operating a central lighting station, the experts entrusted with the examination analyzed conditions in the following manner:

(3)

New York City is confronted with the responsibility of determining the advisability of generating electric current in certain of its public buildings or of continuing the present general practice of buying current from a company operating a central lighting station.

This question presents itself for consideration in three aspects:

1. Whether a gain to the city would result if certain public buildings were equipped to generate electric current in place of purchasing current from electric lighting companies;

2. Whether a gain to the city would result if the electric generating apparatus in certain public buildings were dismantled, the apparatus sold, and current purchased from an electric lighting company;

3. Whether a gain to the city would result if the electric generating apparatus in certain public buildings now equipped were shut down, the apparatus left idle, and current purchased from an electric lighting company.

In addition to reference and analysis, the aim of a study is often fixed by a letter of instruction from client to expert. An obvious example, suggestive of the relations between employer and employee, is the following letter from George W. Rafter, Engineer to the Secretary of the Water Storage Commission of New York, regarding the duties of subcommittees:

(4)

(1) Examination should be made as to whether means are perfectly assured for admitting air under the dam, as on whether or not a sufficiency of air is admitted will depend the flow within a range of about 10%.

(2) An accurate measurement of the length of crest should be made. For this purpose, until the water becomes low during the summer season, an engineer with each party will usually be required. . . .

(3) A short distance above the dam, wherever a uniform channel may be found, a cross-section of the stream should be made in order to estimate velocity of approach. . . .

(4) If the dam is at all irregular, a careful profile should be made in order to subdivide it into a number of level sections. . . . A working engineer will also be required for (3) and (4).

Finally, the aim of an investigation may be fixed by an agreement in the form of a contract binding both parties. Such an agreement was the basis of the *Report of Commission on Additional Water Supply for the City of New York.*

(5)

In accordance with the terms of an agreement made with the Department of Water Supply, Gas and Electricity . . . this Commission was created to "make a thorough, complete, and exhaustive examination and investigation of" certain subjects connected with an additional supply of water for the City of New York, as expressed in the following instructions embodied in that agreement:

(A) The quickest and best method of reducing the waste of water in the City to the lowest practicable amount, the quality of water derived from the various present sources of water supply, with recommendations as to the most practicable means of improving such quality, the pressures in the distribution of the present supplies of water, and of any future supplies, and the methods generally for such distribution for the purpose of attaining the highest practicable degree of fire protection.

(B) The probable future consumption in each of the Boroughs of Greater New York up to such time as shall seem best to the Commission, giving due consideration to the probable increase of population, and its consumption per capita and of the reduction of waste by the efficient execution of the methods therefor proposed by the Commission.

(C) The future source of supply for the City which shall be most available from the point of view of cost and quality of water, to meet the probable future conditions of the City, with the estimated cost of each, the probable yield of water from each, and the length of time required to complete each, with general plans and specifications.

(D) The feasibility of developing a temporary and supplementary supply of water at comparatively moderate cost, pending the completion of the permanent future supply.

Although these four devices—reference, analysis, letter, and agreement—represent all the methods by which the aim of an examination may be fixed, they are not always employed with the mathematical rigidity suggested by the passages which have been quoted above. An interesting variation is that preserved in the *Report on Transportation Subways, City of Chicago,* by which authority was successively delegated by the City Council to the Chairman of the Committee on Local Transportation, to the Commissioner of Public Works, and, finally, to the City Engineer. Another common variation is that found in the *Report on Onondaga Creek Flood Prevention* (Syracuse, N. Y., 1927), by Glenn D. Holmes. The report contains "an amendment to Chapter 356 of the Laws of 1907, approved March 20, 1925." This act directs the Board:

(6)

To make surveys, examinations, maps, and plans of Onondaga Creek, Furnace Brook, and Harbor Brook drainage areas and such other investigations as the Board deems necessary for the preparation of detailed plans and estimates of costs and report with recommendations to the Mayor and Common Council on the extent of damages likely to accrue from major floods; also the cost of constructing suitable protection works. . . .

Such was the origin of Mr. Holmes' study. In essence, however, the procedure always assumes one of the forms suggested above.

Scope of the Investigation.—Although the ultimate purpose and, usually, the immediate purpose of any examination is fixed by the client, who is responsible for its inception, the scope of

the investigation—that is, the limits within which it is to be realized—is usually determined by the expert. It is true, of course, that there are ordinarily restrictions as to time or expense. In one instance, when a study was to be made of the waste in a particular industry, only three months were available for the entire investigation. For another study dealing with construction of a vehicular bridge from Staten Island across Raritan Bay the legislature of the State of New Jersey appropriated the sum of $25,000 and specified that the survey should be completed within a period of six months. Aside from such restrictions, the boundaries are always set by the examiner himself. Their character will depend upon the nature of the subject. As in the surveys of a district like New Ontario or Northern Quebec, the expert, who can draw on his experience with similar ventures, can foresee, with considerable accuracy, the channels to be followed. From time to time, however, he will be forced to alter the course which he has charted. If the expert is to make the most of his opportunities, he must be prepared to alter the range of his investigation as circumstances dictate. In any examination, a tendency towards finiteness is a fatal defect. Consequently, although large investigating agencies like the Stone and Webster Engineering Corporation stress the importance of a definite settlement of the scope of a report in the letter of authorization, they do not guarantee a price. Unexpected contingencies must be provided for. Nevertheless, although any limitation is necessarily tentative, and is subject to revision as the study progresses, there can be little doubt about its usefulness. An early decision regarding the scope of an investigation is of vital importance.

Method to be Followed.—Not only the scope, but also the method of attack, which lies entirely within his jurisdiction, must be decided by the expert. In this decision, as in the other, he can fall back upon experience. If, as is probable, he has been engaged in similar undertakings, he will be familiar, in a general way, with the procedure that is likely to be most expeditious. If he is a "tenderfoot" and cannot draw on the results of his own explorations, he can at least draw on those of others. To them and to the records which they have left he

should turn at once for guidance. Indeed, an essential step in determining the method that is best adapted to the circumstances is a study of the routine which has been developed in practice. A study of this kind will direct attention to the advantages and disadvantages of any plan of campaign. It will certainly promote economy and efficiency.

The scheme which has just been outlined is illustrated by the following extract from the *Report of the Metropolitan Sewerage Commission of New York:*

(7)

PLAN OF INVESTIGATIONS

After considering how the sewage disposal problems of other cities had been met, the Commission laid out the line of investigation which was to be pursued.

The immediate objects of the program were:

First. To establish the facts attending the discharge of the sewerage;

Second. To determine the extent to which the conditions were injurious to the public health and welfare; and

Third. To ascertain the way in which it would be necessary to improve the conditions of disposal in order to meet the reasonable requirements of the present and future.

In this examination, one of the essential features of the office work was a consideration of the ways in which the sewerage problems of other cities had been solved. In the light of the information secured in this manner, the engineers and scientists concerned formulated the procedure indicated roughly above. The plan included studies in assimilation under different circumstances; analyses—chemical, bacteriological, and microscopical—of samples taken from all parts of the harbor; investigations of tidal phenomena, and estimates of population and effluvia. All these details were considered before the field work was begun.

Although the method adopted is usually formulated at first rather loosely, it is sometimes fixed more definitely. If there

is a formal contract between expert and client, it may be possible, and even advisable, for the former to define the procedure with more than ordinary exactness, to explain it in conference, and to incorporate it in the agreement to which both are parties. For the investigation regarding the cost of operation and maintenance of a power plant in the Hall of Records in New York, a detailed scheme, described in the passage quoted below, was drafted beforehand:

(8)

CONDITIONS

1. The period of observation is to be one year.

2. The test is to be conducted under the supervision of a committee of engineers representing the following parties:

President of the Borough of Manhattan
New York Edison Company
Department of Water Supply, Gas and Electricity
Bureau of Municipal Research

3. The cost of obtaining expert services up to the amount of ten thousand dollars ($10,000) is to be borne by the New York Edison Company.

4. The President of the Borough of Manhattan is to install the necessary apparatus for metering and recording the quantities of steam, water, and other factors involved in the operation of the plant. Such special apparatus as may be necessary for test purposes is to be provided by the New York Edison Company or the Department of Water Supply, Gas and Electricity.

5. Immediate supervision of the plant during the test period is to remain in the hands of the consulting engineer of the Borough of Manhattan, who will assign a special assistant for this purpose. Monthly, or oftener, the Borough consulting engineer will transmit to the other members of the committee of engineers reports, in agreed form, giving the results of operations in the preceding month.

6. Observers are to be employed for the period of one year, representing the New York Edison Company and the Bureau of Municipal Research, to be stationed at the plant night and day throughout the period of the test. These observers are to be under the supervision of Professor Diederichs, to whom they will report.

7. From time to time, and not less than three times during the

year, nor more than six, a twenty-four hour unannounced test is to be made by the engineers representing the parties above named in order to determine the accuracy of the recording devices and the general conditions of operation. For this purpose, special assistants are to be employed.

8. The location and type of recording devices are to be determined in conference by the representatives of the parties above named on the basis of an examination of the plant by Messrs. Goodrich, Bolton, Lucke, and Diederichs.

9. For the purpose of the test, the plant of the Hall of Records will supply steam and electricity to the City Hall, brownstone building, and county court-house, the cost of necessary connections to be borne by the City.

10. At the conclusion of the test, the operating data obtained are to be submitted to a group of accountants representing the President of the Borough of Manhattan, the New York Edison Company, and the Bureau of Municipal Research to ascertain the money cost of generating electricity during the test period.

In advance of beginning the test, it is suggested that a statement be prepared for publication setting forth the conditions and purposes of the test and that this statement be issued by the President of the Borough of Manhattan.

Even in this instance, however, the procedure was altered materially by changes in the relations among the contracting parties. It should not be forgotten that the preliminary plan, which is a "function" of the scope, and varies with it, should never be allowed to crystallize into permanency. On the other hand, the value of experience cannot be exaggerated. The expert, who has seen others at work, and who has developed a flair for the right move, is seldom at a loss. Whether he outlines his campaign loosely or exactly, he is usually able to proceed swiftly and decisively.

Use of Literature.—Even after he has received his commission and has decided on the scope and method of examination, no investigator will be fully equipped for the duties of the field. Consultations with clients and discussions with friends and colleagues, to whom even the greatest specialist turns for counsel and advice, are invariably supplemented by researches in the literature of the subject. Although these researches

may be carried on in his office, an expert may find it necessary to draw on the libraries which are convenient. Since the technique of reference is described at length in Chapter 15, which deals with the experimental report, it need not be explained here. Attention can therefore be focussed upon the three categories—*particular, correlated,* and *general*—into which the data collected through literary researches naturally fall.

In all probability, these researches will be first directed toward certain specific ends. There are usually maps and records, franchises and opinions, and mortgages and agreements that must be secured and scrutinized. An investigation of a timber limit which was recently offered for sale required an examination of a map of the district in which it lies. An estimate of the value of the stock on a farm in Quebec necessitated a verification of the pedigree. The success of a public service corporation in New York seeking capital for expansion depended on the nature of its franchise. The feasibility of a hydroelectric project in one of the western states hinged on an opinion regarding riparian rights. The length of time a number of mortgages at low rates had to run determined the attitude of investors toward a factory in the East; and an agreement regarding representation in a particular territory affected materially the prestige of a subsidiary organization. Office work of the character indicated is always necessary.

In addition to documents like those mentioned in the preceding paragraph which may be regarded as cornerstones of the study which is being conducted, and which will probably be introduced in the report itself as exhibits, many data—especially those in the bulletins issued by the governments of the United States and Canada—are already correlated and ready for use. An investigation of a hydroelectric project, for instance, requires reference not only to maps and records, franchises and opinions, and mortgages and agreements, but also to the facts regarding population and transportation—to be found in census and railroad reports—as well as to those regarding precipitation and temperature, which are to be found in other national compilations. Of the sources for general statistics, some at least should therefore be familiar. One of

the most important is *The Statistical Abstract of the United States* (Washington, D. C., 1879 —), which contains data, arranged chronologically in tables, on manufacturing, transportation, mining, agriculture, forestry, etc. In their own fields, Poor's *Manual of Industrials* and *Manual of Public Utilities,* and Moody's *Analyses of Investments* and *Manual of Railroads and Corporation Securities* are standard. These and similar compilations are often invaluable.

The publications of such federal agencies as the Bureau of the Census, including censuses of manufactures, agriculture, and distribution, the Bureau of Foreign and Domestic Commerce, the Federal Trade Commission, the Federal Power Commission, and the National Resources Committee, are all of use in the collection of data for reports. Of particular aid in market research is the biennial *Market Research Sources* formerly *Market Research Agencies: A Guide to Information on Domestic Marketing, Prepared by the Marketing Service Division of the United States Department of Commerce, Bureau of Foreign and Domestic Commerce, Domestic Commerce Series* 55 (1936), which "contains a classified description of currently useful research results in the marketing field. . . . " Listed in the *Guide* are thousands of agencies and reports on every phase of business. It should be consulted by any one who contemplates a study in merchandising. "Such a compilation serves two purposes—a source book for individuals interested in marketing research and a check upon the plans of others interested in conducting research projects in this broad field."

There remains to be considered the last of the three categories under which the data secured through literature have been grouped. Besides facts which bear directly upon a specific problem, and those which bear indirectly upon it, there are others, more general in character, which may possibly throw some light upon the subject. A survey of the entire literature may be then advisable. Nevertheless, although there are often cases in which an expert confronted with a novel situation does undertake a study of this nature, these cases, after all, are relatively few. In practice, reference is restricted to the data

which have been characterized as "particular" or "correlated." It is therefore possible to turn, without further delay, to the activities of the field.

Exercise: Secure by means of an examination of the card catalog of your library a list of general reference works for office use in the preparation of an examination report on a particular subject, such as one of those suggested on page 331 or 420. Give the call numbers and indicate in your report the completeness and up-to-dateness of the library files. Include those mentioned in the text and any others which seem to you of importance.

CHAPTER 10

EXAMINATION REPORTS—FIELD WORK

Main Steps in the Field Work.—In the field work required under normal conditions, there are a number of distinct steps, which may be indicated by the following outline:

- I. 1. Preliminary Examination
  - 2. Tentative Result
    - A. Information Available
    - B. Information Required
- II. 1. Final Examination
  - 2. Permanent Result

Preliminary Examination and Tentative Result.—The nature of the preliminary examination and the tentative result can best be made clear by reference to a couple of characteristic studies.

If the investigation has been undertaken in order to secure data regarding the feasibility or cost of construction, the aim and the conclusion are similar to those set forth in the following passage from the *Report of the Transit Commissioner, City of Philadelphia:*

(1)

Study of North and South Elevated Line

Early in this investigation, a preliminary study was made for a north and south elevated railway route located in whole or in part on private property and crossing Market Street near the center of the delivery district. The most feasible location for such a route at Market Street is near the middle of the block between Ninth Street and Tenth Street, passing just west of the Post Office. From Ridge Avenue to Market Street, this line presents no great engineering difficulty, although the right-of-way would extend through much valuable property, which would have to be secured

therefor. Between Market and Spruce Streets, the cost of the right-of-way was deemed prohibitive.

No cost estimates of this alternate route, which was not deemed feasible, have been completed. The studies made have emphasized the desirability of securing a wide north and south highway through the center of the delivery district in order to reduce the congestion of street traffic; and it should be provided for in the City Planning for the future.

In this case, the preliminary survey pointed to a definite location. It showed that no special engineering difficulties were likely to be encountered and that, although the line would run through a great deal of valuable property, the purchase price would not be excessive. Above all, it established the fact that the cost of the alternative route would be prohibitive.

Where the examination report is to be made the basis of a construction report, the function of the preliminary study is to establish the feasibility of the proposed development from an engineering and also from a financial point of view.

When the examination report, on the other hand, is final in character—that is, when an expert is concerned with facts and not with their applications—the preliminary survey is necessarily different. Its nature is suggested by the following extract from the *Report to the International Joint Commission Relating to the Official Reference to the Lake of the Woods Levels,* by Adolph F. Meyer and Arthur V. White, Consulting Engineers:

(2)

Field operations prosecuted by our engineers and assistants in the northerly portion of the Lake of the Woods consisted, primarily, of a reconnaissance examination and sketching, with the aid of pocket compass and hand level, of the smaller, isolated, low areas not surveyed by the transit and planetable parties operating in the southerly portion of the Lake. The portion of the Lake covered by these reconnaissance examinations is characterized by high bluff shores, enclosing here and there small areas of low land bordering bays and inlets. Usually these areas, consisting mainly of marsh and bog, are quite flat, and are bordered on the one side by water, and on the other by high rocky ridges. On the field

sketches were drawn the 1,063 contour and the water's edge, the latter being an elevation of approximately 1,060, and, so far as it could be readily determined by sounding and by noting the margin of vegetation, the 1,058 contour was also located and drawn. In addition, information was noted with respect to the character of the land, vegetal cover, improvements, etc.

The sketches resulting from this examination are shown on Reconnaissance Sheets 1 to 3 and Key Map of Atlas.

A summary of the reconnaissance areas of the northerly portion of the Lake of the Woods follows:

Between Contours	Timbered Land of All Kinds	Grass, Brush, Marsh, Water	Total Area Acres
1,058 and 1,060	.....	2,221.8	2,221.8
1,060 and 1,063	733.5	3,897.6	4,631.1
1,058 and 1,063	733.5	6,119.4	6,852.9

Often, as here, or in a preliminary survey for a water-supply system, a flood-prevention project, or a hydroelectric enterprise, the reconnaissance deals primarily with the topography and vegetation of the district. A mining expedition, "staked" by a capitalist interested in the possibilities of a mineralized area, would be attracted by the formations encountered; a preparatory study of a retail area would locate stores, traffic routes, residential districts, and the flow of trade; and the initial study of a mill, a factory, or an organization would be directed towards the discovery of the determinative factors, whether materials, processes, or persons, that require special consideration. In general, the aim of the preliminary examination is to provide the expert making it with a tentative grasp of the situation confronting him and an idea of the line of attack that promises to be most effective.

Final Examination.—In preparing, in his office, for the preliminary examination, the expert draws upon both experience and literature. In the preliminary examination, which is largely field work, and which covers superficially much, or

all, of the territory, material, technique, or staff involved, experience is a handmaid of observation. In the final examination, to which the other steps are introductory, observation, whether active or passive, is usually supplemented by an interview or a questionnaire. The results secured in these two ways are matters of fact or opinion, which must be sifted and classified; and the methods employed are, therefore, those of analysis and record.

Importance of Observation.—In an examination, observation may be entirely passive; that is, the expert may be merely a commentator analyzing and recording his impressions of materials, processes, or persons. In this case, all that he will desire will be an idea of the appearance of certain substances, the efficiency of certain units, or the comfort of certain employees. His chief concern, therefore, is to select and to preserve the pertinent facts regarding them. In so far as success in selecting facts depends upon temperament as well as upon training, it is hardly a profitable subject for discussion. In preserving facts, however, success depends entirely upon skill in the arrangement of notes, a procedure which can be explained without difficulty. For this reason the subject is treated at length in the latter part of this chapter.

Sampling.—In many examinations an essential feature is the determination of the state, quality, or efficiency of certain materials, either raw or manufactured. Under such circumstances, observation necessarily ceases to be passive. The facts required can be secured only by a process of analysis based on physical manipulation. Since it is impossible to test every part of the substance or every member of the series involved, it is customary to select a mass or group of representative specimens and to reduce them progressively in quantity or number in order to obtain a working basis for laboratory investigation. The selection and reduction, with the subsequent analysis, together constitute what is known as "sampling."

It need hardly be said that the purpose of sampling is to produce an accurate impression of the entire substance or series. To produce such an impression is not an easy task.

In a well-known city on the Hudson, a contractor is reported to have made a fortune by building asphalt pavements in which the plots tested by his accomplices in the municipal bureaus alone met the specifications. Although there is little ground for the assumption that such dishonesty is prevalent among men of affairs, the popular belief in the story emphasizes the need of caution in choosing the specimens to be reduced. Since it is often difficult, and even impossible, to replace them for analysis, mistakes in selection can seldom be rectified. Although irregularities in the process of reduction—which, at best, is always responsive to the law of chance—are less serious, and are not likely to affect the result, the routine adopted must be sufficiently regular to promise retention of the representative qualities of the substance or series which is to be analyzed.

Sampling Applied to Quantity.—In spite of the fact that it is not practical to consider all the technicalities of sampling, many of which require training and dexterity, the procedure in the case of a particular substance such as coal will illustrate the principles of selection and reduction as applied to quantity.

The routine is outlined in *Analysis of Mine and Car Samples of Coal Collected in the Fiscal Years 1913-1916*, Bureau of Mines Bulletin 123 (1916),[1] by Arno Fieldner, Howard I. Smith, J. W. Paul, and Samuel Sanford. With it may be compared that advocated by the American Society for Testing Materials in its *Standard Methods for Sampling of Coal:*[2]

(3)

1. For All Determinations Except Total Moisture

TIME OF SAMPLING

1. The coal shall be sampled when it is being loaded into, or unloaded from, railroad cars, ships, barges, or wagons, or when discharged from supply bins, or from industrial railway cars, or grab buckets, or from any coal-conveying equipment, as the case may be. If the coal is crushed as received, samples usually can be taken advantageously after the coal has passed through the crusher. Samples collected from the surface of coal in piles or bins or in cars, ships, or barges, are generally unreliable.

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[1] Out of print.

[2] Series Designation: D21-16. These directions appear in the volume *A.S.T.M. Standards*, issued triennially. The current issue is dated 1936.

2. To collect samples, a shovel or specifically designed tool, or mechanical means, shall be used for taking equal portions or increments. For slack or small sizes of anthracite, increments as small as 5 to 10 lb. may be taken; but for run-of-mine or lump coal, increments should be at least 10 to 30 lb.

SIZE OF INCREMENTS

3. The increments shall be regularly and systematically collected, so that the entire quantity of coal sampled will be represented proportionately in the gross sample, and with such frequency that a gross sample of the required amount shall be collected. The standard gross sample shall not be less than 1,000 lb., except that for slack coal and small sizes of anthracite, in which the impurities do not exist in abnormal quantities, or in pieces larger than ¾ inch, a gross sample of approximately 500 lb. shall be considered sufficient. If the coal contains an unusual amount of impurities, such as slate, and if the pieces of such impurities are very large, a gross sample of 1,500 lb. or more shall be collected. The gross sample should contain the same proportion of lump coal, fine coal, and impurities as is contained in the coal sampled. When coal is extremely lumpy, it is best to break a proportional amount of lumps before taking the various increments of a sample. Provision should be made for the preservation of the integrity of the sample.

COLLECTIONS OF GROSS SAMPLE

4. A gross sample shall be taken for each 500 tons or less, or in case of larger tonnages, for such quantities as may be agreed upon.

QUANTITY REPRESENTED

5. After the gross sample has been collected, it shall be systematically crushed, mixed, and reduced in quantity to convenient size for transmittal to the laboratory. The sample may be crushed by hand or by any mechanical means, but under such conditions as shall prevent loss or the accidental admixture of foreign matter. Samples of the quantities indicated in Table I shall be crushed so that no pieces of coal and impurities will be greater in any dimension as adjudged by eye, than specified for the sample before division into two approximately equal parts.

CRUSHING

The method of reducing by hand the quantity of coal in a gross sample shall be carried out as prescribed in Section 6 even should the initial size of coal and impurities be less than indicated in Table I.

TABLE I

Weight of Sample to Be Divided, Lb.	Largest Size of Coal and Impurities Allowable in Sample Before Division, In.
1,000 or over	1
500	$\frac{3}{4}$
250	$\frac{1}{2}$
125	$\frac{3}{8}$
60	$\frac{1}{4}$
30	$\frac{3}{16}$ or 4-mesh screen

HAND PREPARATION

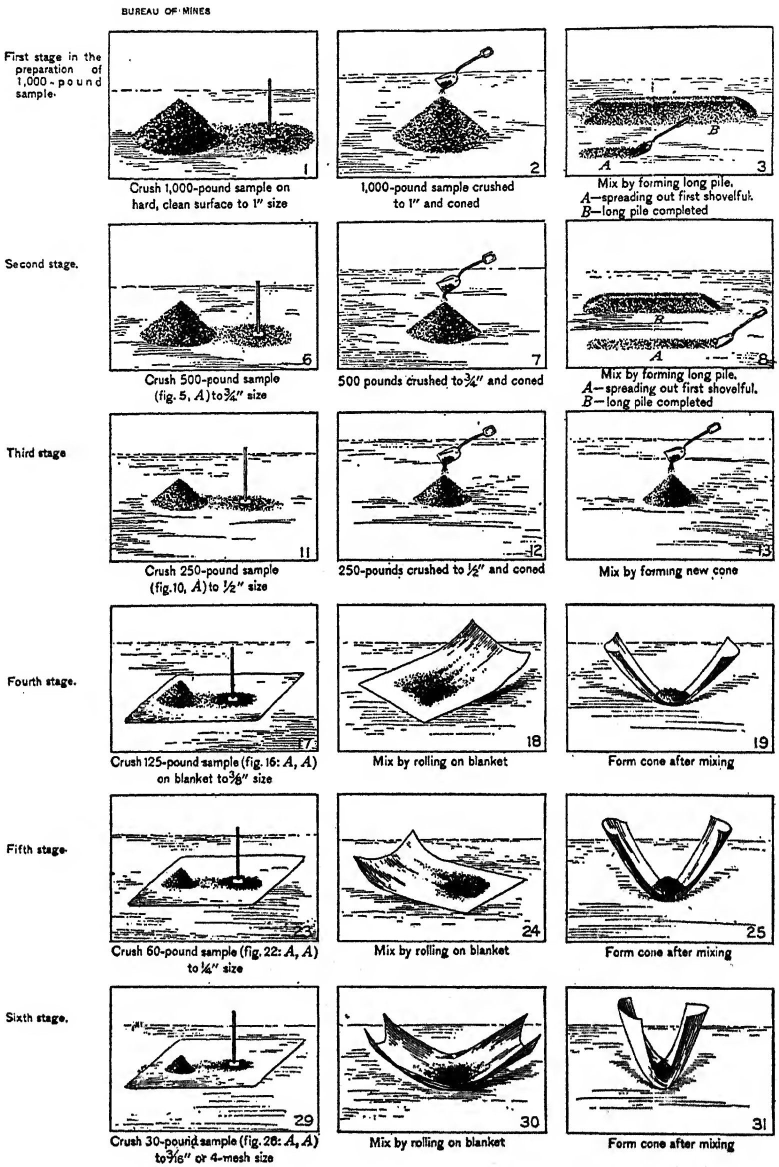
6. The progressive reduction in the weight of the sample to the quantities indicated in Table I shall be done by the following methods which are illustrated in Plate V:

MIXING AND REDUCTION BY DISCARDING ALTERNATE SHOVELFULS

(a) The alternate-shovel method of reducing the gross sample shall be repeated until the sample is reduced to approximately 250 lb., and care shall be observed before each reduction in quantity that the sample has been crushed to the fineness prescribed in Table I.

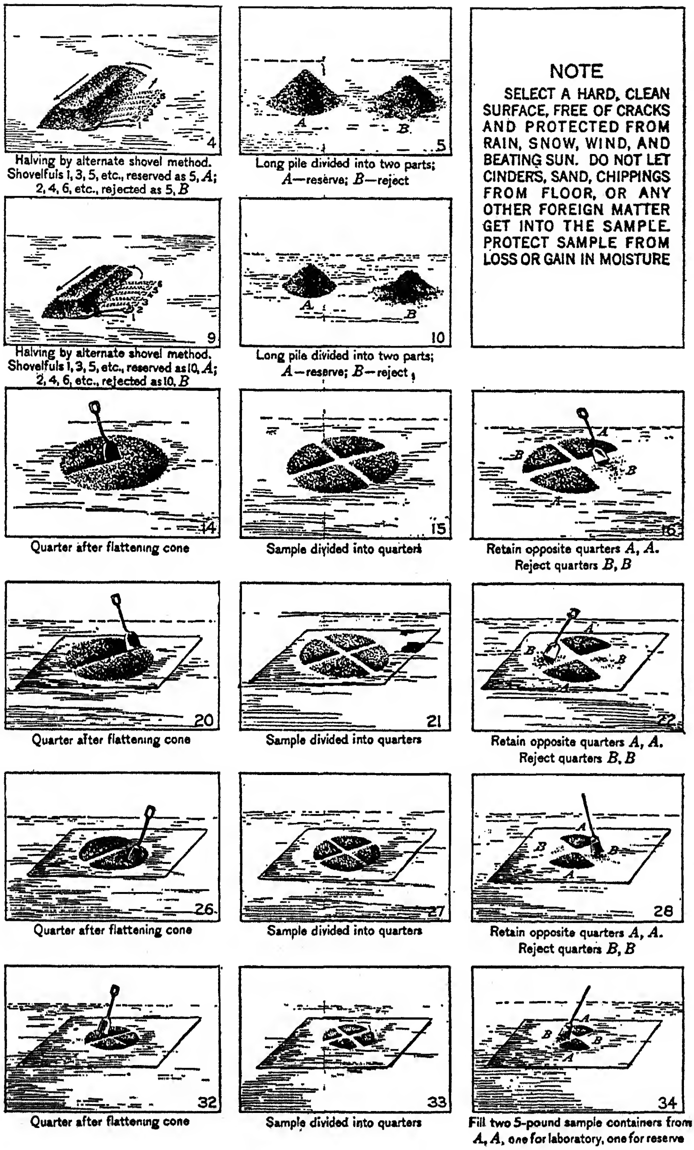
The crushed coal shall be shoveled into a conical pile (Figs. 2 or 7, Plate V) by depositing each shovelful of coal on top of the preceding one, and then formed into a long pile in the following manner: The sampler shall take a shovelful of coal from the conical pile and spread it out in a straight line (Figs. 3A or 8A) having a width equal to the width of the shovel and a length of 5 to 10 feet. His next shovelful shall be spread directly over the top of the first shovelful, but in the opposite direction, and so on back and forth, the pile being occasionally flattened until all the coal has been formed into one long pile (Figs. 3B or 8B). The sampler shall then discard half of this pile, proceeding as follows:

Beginning on one side of the pile, at either end, and shoveling from the bottom of the pile, the sampler shall take one shovelful (shovelful No. 1, Figs. 4 or 9) and set it aside; advancing along the side of the pile a distance equal to the width of the shovel, he shall take a second shovelful (shovelful No. 2) and discard it;



Method of Preparing a Sample of Coal by Hand. The necessary tools are a shovel, tamper, blanket measuring about 6 by 8 feet, broom, and rake. The coal is raked while being crushed, so that all lumps will be crushed.

BULLETIN 116 PLATE V



4. Halving by alternate shovel method. Shovelfuls 1, 3, 5, etc., reserved as 5, *A*; 2, 4, 6, etc., rejected as 5, *B*

5. Long pile divided into two parts; *A*—reserve; *B*—reject

9. Halving by alternate shovel method. Shovelfuls 1, 3, 5, etc., reserved as 10, *A*; 2, 4, 6, etc., rejected as 10, *B*

10. Long pile divided into two parts; *A*—reserve; *B*—reject

14. Quarter after flattening cone

15. Sample divided into quarters

16. Retain opposite quarters *A*, *A*. Reject quarters *B*, *B*

20. Quarter after flattening cone

21. Sample divided into quarters

22. Retain opposite quarters *A*, *A*. Reject quarters *B*, *B*

26. Quarter after flattening cone

27. Sample divided into quarters

28. Retain opposite quarters *A*, *A*. Reject quarters *B*, *B*

32. Quarter after flattening cone

33. Sample divided into quarters

34. Fill two 5-pound sample containers from *A*, *A*, one for laboratory, one for reserve

Floor or blanket is swept clean of discarded coal each time after sample is halved or quartered.

again advancing in the same direction one shovel width, he shall take a third shovelful (shovelful No. 3) and add it to the first. The fourth (shovelful No. 4) shall be taken in a like manner and discarded, the fifth (shovelful No. 5) retained, and so on, the sampler advancing always in the same direction around the pile so that its size will be gradually reduced in a uniform manner. When the pile is removed, about half of the original quantity of coal should be contained in the new pile formed by the alternate shovelfuls which have been retained. (Figs. 5A or 10A show the retained halves, and Figs. 5B or 10B, the rejected halves.)

MIXING AND REDUCTION BY QUARTERING

(b) After the gross sample has been reduced by the above method to approximately 250 lb., further reduction in quantity shall be by the quartering method. Before each quartering, the sample shall be crushed to the fineness prescribed in Table I.

Quantities of 125 to 250 lb. shall be thoroughly mixed by coning and re-coning (Figs. 12 and 13); quantities less than 125 lb. shall be placed on a suitable cloth measuring about 6 by 8 ft., mixed by raising first one end of the cloth and then the other (Figs. 18, 24, or 30) so as to roll the coal back and forth, and, after being thoroughly mixed, shall be formed into a conical pile by gathering together the four corners of the cloth (Figs. 19, 25, or 31). The quartering of the conical pile shall be done as follows:

The cone shall be flattened, its apex being pressed vertically down with a shovel, or board, so that after the pile has been quartered, each quarter will contain the material originally in it. The flattened mass, which shall be of uniform thickness and diameter, shall then be marked into quarters (Figs. 14, 20, 26, or 32) by two lines that intersect at right angles directly under the point corresponding to the apex of the original cone. The diagonally opposite quarters (BB in Figs. 16, 22, 28, or 34) shall then be shoveled away and discarded and the space that they occupied brushed clean. The coal remaining shall be successively crushed, mixed, coned, and quartered until the sample is reduced to the desired quantity.

(c) The 30-lb. quantity (Fig. 29) shall be crushed to 3/16 in. or mesh size, mixed, coned, flattened, and quartered. The laboratory samples shall include all of one of the quarters, or all of two opposite quarters (Fig. 34) as may be required. The laboratory sample shall be immediately placed in a suitable container and sealed in such a manner as to preclude tampering.

7. Only such mechanical means as will give equally representative samples shall be used in substitution for the hand method of preparation herein standardized.

MECHANICAL PREPARATION

It is obvious that this method, which is so simple that it requires no explanation, is also applicable to other materials which must be tested in bulk. Procedures for soils and cements, ores and metals, oil and gas, and other substances are described in the *Bulletins* of the Bureau of Chemistry, the *Standards* of the American Society for Testing Materials, the *Transactions* of the American Society of Civil Engineers, the *Pamphlets* of the Chemists' Committee of the United States Steel Corporation, and the *Technical Papers* of the Bureau of Mines.

After a relatively small amount of the substance to be sampled has been obtained by the procedure outlined above, it must be subjected to analysis. Since the methods employed are matters of laboratory practice with which the expert making the examination may not be familiar, he often has recourse to other specialists, whom he consults exactly as he himself has been consulted by his clients. These methods may be classified as

I. Macroscopical or Microscopical
II. Manual or Mechanical
III. Quantitative or Qualitative
IV. Physical or Chemical

In recording the results—a subject which is treated fully in Chapter 11, where it properly belongs—it is necessary to express them in terms of recognized units. Whatever these units of measure may be—whether scientific or engineering, metric or English—there must be no variation.

Sampling Applied to Number.—When the principles of sampling are applied to a series, selection and reduction, which, in this case, are inseparable, are based upon intervals of space or time chosen according to an arbitrary but nevertheless consistent policy. For instance, if an expert wishes to determine the buying habits of families, he may interview the housewife

in every twentieth house of the selected district, the so-called five per cent cross-section of family groups. If he wishes to test the soundness of the ties on a section of railroad track, he may pick out one in fifty as representative. Where, as often happens, he has to deal with efficiency instead of with economy; where, for instance, he is concerned with the accuracy of a mechanism or the power of a machine, the process of selection and reduction is necessarily dependent upon intervals of time instead of space. The tests, which, in such instances, take the place of the analyses mentioned in the last paragraph, may be run during the first and last hours of each day in the month; or, again, to meet specific conditions, they may be run during periods which do not fall into any regular sequence except in so far as they relate to a special set of circumstances. Whatever the system adopted, the aim is always that which has been stressed as fundamental—to indicate as accurately as possible the normal performance of the units examined. Here, also, the expert, whatever his training, may be forced to seek the assistance of a specialist.

In his *Report of a Research into the Attitudes and Habits of Radio Listeners* (St. Paul, 1933), Professor Clifford Kirkpatrick indicates succinctly both the problem and the technique which he adopted in sampling radio listeners in Minneapolis:

(4)

The aim of any investigation such as the one here undertaken is to deal with a sample which is adapted to the limitations of time and money and yet has the widest possible range of implications in view of its similarity to the larger universe which it represents. . . . The problem was to select a representative sample of adult radio listeners and to see to it that those who returned answers were as representative as possible of the original sample. . . . It was decided to select the first name associated with a residential number in the first and last column of each page of the Minneapolis *Telephone Directory*.[8]

In succeeding pages Professor Kirkpatrick produces abundant evidence to show "that the sample has a reasonable degree of validity."

[8] Reprinted by permission of the author.

Similarly, Professor J. H. Leuba in his study, "Religious Beliefs of American Scientists," *Harpers Magazine*, 169:291-300 (August, 1934), used a similar rule of chance to secure a list to which to send his questionnaire. He writes:

(5)

According to the experimental findings of statisticians, the answers of even one-tenth of a group, when it includes several hundred individuals, yield results very like those which would be obtained if every individual in the group had answered—this, providing no vitiating selection in the choice of the tenth has taken place.

By a rule of chance Professor Leuba selected one-tenth of the names in two classes, "physicists, including all those concerned with inanimate matter, and biologists—those concerned with living matter." A similar procedure was followed in selecting a list of psychologists and sociologists.

The criteria for the proper sampling of a population group have been summarized briefly by Helen M. Walker in the *Teachers College Record*, 30:761 (May, 1929):

1. The chance to be chosen in a particular sample must be uniform for all members of the total population.
2. The chance for a given member of the total population to be chosen must be constant from sample to sample.
3. The chance that a given individual shall be included in a sample must be in no way affected by the previous choice of another individual.[4]

Theory of Sampling.—Mathematical and mechanical considerations do not, however, always determine the method of sampling or the selection of the sample itself, especially in the realm of social, educational, and economic surveys. For instance, in its interesting survey, *Markets by Incomes: A Study of the Relation of Income to Retail Purchases in Appleton, Wisconsin* (New York, 1932), *Time* tells why Appleton, Wisconsin, was chosen as a sample city from which to secure answers to the question, "How do people in the different in-

[4] Reprinted by permission of the Bureau of Publications, Columbia University.

come brackets spend their money?" First it was decided that a city of 25,000 population was "the largest that could conveniently be surveyed." Research directors of several large advertising firms recommended the Middle West; and "Wisconsin, with its liberal income tax laws, made it possible for *Time* to do away with all guesswork. . . . Of all cities in Wisconsin Appleton was the ultimate choice . . . independent market . . . center of better than average farming and dairy district . . . diversity of manufactures . . . population—25,267. With no slums and no Peacock Alley, it fairly represents the United States Market without the extremes which unbalance the income distribution of many another city."

" . . . *Time* surveyed in detail the buying of

431 out of 4,444 families with incomes	under	$ 2,000
196 out of 978 families with incomes of	$ 2,000	3,000
231 out of 438 families with incomes of	3,000	5,000
154 out of 220 families with incomes of	5,000	10,000
87 out of 119 families with incomes of	10,000	and over

Or one family out of every six. . . . Names for samples were selected alphabetically." [5]

Thus it is apparent that in actual practice sampling is not only a mathematical problem in the theory of attributes and variables.[6] It is also a practical problem. The sample should be as representative as possible and should be as large as can be conveniently examined; but both these factors should be subordinated to the essential considerations of aim, scope, and importance. Since conclusions based on any method are open to criticism on the ground of validity, the investigator should guard against unwarranted assumptions. Indeed, the employment of any of the procedures dependent upon the theory of sampling requires judicious care. Nevertheless, it is possible to calculate the normal fluctuations to be expected and to determine the reliability of results with considerable accuracy. Although it is often customary to assume that three times the

[5] Reprinted by permission of *Markets by Income*, an advertising promotion production of Time, Inc.

[6] For a full discussion of the underlying mathematical theories and the techniques of sampling, consult such a treatise as Professor T. C. Fry's *Probability and Its Engineering Uses* (New York, 1928).

standard error is the range within which most variations in sampling fall, the generalization should be accepted with caution. What it is well to remember is that most differences are due to three factors:

1. The causes under investigation
2. The normal fluctuations in sampling
3. The irregularities of reduction

Procedure in an Interview.—Fully as important as observation, whether it be passive or active, is the interview, by which an enormous amount of information used in reports is obtained. Reports as far apart in purpose as the *National Power Survey,* of the Federal Power Commission, the social surveys of cities conducted by the Russell Sage Foundation, the consumer studies of the Department of Commerce, and the *Investigation of Engineering Education,* prepared for the Society for the Promotion of Engineering Education, make extensive use of the interview.

In an interview, the expert makes a personal appeal to, or a personal demand of, those from whom he desires to obtain information. This appeal or demand must be in keeping with the position of the officials whom he has elected to interview. Before approaching those whom he cannot command—executives, for instance, who are interested in similar problems—he should secure suitable letters of introduction containing the essential facts regarding his experience and purpose. If he does not take this precaution, he may fail to obtain an audience. Before approaching those whom he can command—employees, for example, in his client's factory—he should provide himself with letters of instruction issued by the competent authorities. If these letters are forwarded directly to the subordinates to whom they are addressed, they are likely to be more effective than if they are presented without notice. Where is it at all practicable, the person to be interviewed should be given the privilege of preparation which the interviewer regards as necessary. Since every interview, whatever its character, is really a miniature examination, the procedure to be adopted is that which has been outlined in this chapter. A certain amount of

office work must precede the field work. After the aim of the interview has been fixed, the interviewer must decide upon the scope of the inquiry, which is usually determined by the time available, and upon the method of approach which is likely to be most successful. The field work which comes afterward will fall, as indicated, into two distinct parts. A tentative survey is always advisable. Before beginning an interview, the expert who is called in from the outside will find it well to learn what he can regarding the education, experience, and responsibility of the men whom he is to meet. Unless he follows this plan, he may flounder hopelessly. If he does follow it, he will certainly work more effectively. Indeed, since the result of any interview depends largely upon the strategy of the interviewer, a preliminary investigation is essential.

Although it may not be possible, and usually is not advisable, to utilize a series of questions that has been prepared beforehand in the light of the knowledge obtained in this way, the mere formulation of such a series is of inestimable value. It will help the interviewer to clarify his ideas and to cover all the points on which he ought to touch. With it in mind, it is not probable that he will overlook, or forget, anything that is fundamental or that he will wander far from his text. Although it is true that, if he is interviewing those who are temporarily subject to his wishes, he can sometimes use a hard-and-fast outline, which will always be of assistance, he ought to remember that after all such an outline is merely a guide which should be abandoned for the line of least resistance. It should never be retained after its usefulness has disappeared. Skill in interviewing, like skill in boxing, is dependent upon readiness to take advantage of the openings which are offered.

Conducting the Interview.—The temper of the two groups which have been mentioned is a matter of importance in conducting an interview. Among the members of the first group—that is, among those whose replies are of courtesy—there is usually too little concern. Among the members of the second group—that is, among those whose replies are of necessity—there is usually altogether too much. To overcome lack

of response or even fear, the interviewer may resort occasionally to such stratagems as entering a plant as an ordinary workman or arming himself with awe-inspiring credentials; but the unfailing requirement for success is to maintain an attitude of sympathetic interest and unfailing politeness. To overcome coolness and hesitation demands a practical knowledge of human nature; and although this is not the place in which to attempt an essay in applied psychology, it is wise to recall that although every one, according to an old saw, hates a schoolmaster, every one, as Sam Slick reiterates in *The Clockmaker,* likes to teach instead of to learn. Only the interviewer who remembers this fact is likely to get very far. Whether he is discussing matters of policy with the head of a rival industry or details of manufacture with a foreman in one of his client's shops, a specialist, whatever his fame, cannot afford to forget that every man, whatever his position, possesses a fund of knowledge which cannot be duplicated exactly by anyone else. Nor can he afford to forget that a fine respect for the feelings of others is twice blest in the richness of its return.

A number of helpful suggestions appear in an abstract of the technique in interviewing developed by the Hawthorne Works of the Western Electric Company, as recorded by M. L. Putnam in "A Plan for Improving Employee Relations on the Basis of Data Obtained from Employees," a paper presented at the Conference of The Personnel Research Federation, New York City, November 15, 1929:

(6)

To try out the scheme of interviewing which had been decided upon in order to obtain information on employee attitudes and relations, a single department was chosen because it seemed to offer a "fair picture" of what "people in various types of work like and dislike. Considerable planning was done before the employees were approached. . . . Five interviewers were selected . . . women to interview women and men to interview men. . . . All comments were to be kept confidential. . . . When the employee was asked to comment, he was assured that he was invited and not ordered to express himself. . . . The interviewer explained the

program . . . and asked if he cared to express his views . . . the interviewer made rather complete notes or took his comments verbatim . . . encouraged him with questions. . . ."

Later it was decided to extend the interviews to other parts of the plant and incorporate certain changes which grew out of the previous experience. "Our first interviews were opinions . . . but they pertained primarily to what the interviewer and not the employee found important," because "each interviewer was mentally equipped with a set of questions which he was expected to have answered by everyone. . . . It seemed that there were several serious defects in the direct question method." As a result there was adopted a "conversational method," which "seems not only to avoid the pitfalls of the direct question, but has unique features of its own . . . it stimulates a feeling of confidence," provides for the employee "an emotional release," and builds up a "feeling of recognition" of the employee, who "feels that the management values the comments of his own choosing, and that he is something more than just the source of answers to questions." In this "Conversational, or Indirect Approach . . . the employee, after an explanation of the program, is allowed to choose his own topics. The interviewer follows his comments in a conversational way or by silence."

Some such technique as the one outlined here will serve to bring out the information which the investigator requires.

Notes in an Interview.—In interviewing each of the two groups described, the preservation of the data obtained is an important point. In the first case, where the questions which may be asked, or suggested, are necessarily informal, it is seldom possible to record the replies at the time when they are made. Even if the topics considered are definitely related to one another, the process of taking notes would be so obtrusive that it would probably destroy the intimacy of the contact which the interviewer has been at pains to establish. Moreover, all that is usually desired, and often all that can be obtained, under such circumstances is a general idea of conditions or tendencies. As cited by most men, statistics are merely illustrative. Even when talking without their files before them, their comments are necessarily impressionistic. Even if it were feasible, an immediate attempt to reproduce the tenor of a conversation is, therefore, likely to end in failure. It is better,

as a rule, to summarize it at a little distance after its significance has become clear. A notebook, consequently, is not needed. In the second case, however, where the topics discussed are invariably details instead of policies, and where the questions are more or less fixed and the replies more or less statistical, a small loose-leaf notebook which will fit conveniently into a pocket is most useful. It has all the advantages of a card index system. The facts secured can be entered at once under headings which have been prepared beforehand. Since their character can be anticipated with reasonable accuracy, ruled sheets with tabular forms which will permit correlation of data can also be employed. Whether the arrangement is by topics or by tables, an explicit reference to the place and date of the interview and the name and position of the person interviewed is fundamental. This information is usually placed at the upper right-hand corner of each entry. As when material is secured by reading, the object of this precaution is to make it possible to verify statements or figures that may conflict with others.

Checking an Interview.—In every interview it is necessary to distinguish between matters of fact and matters of opinion. This distinction is one of the essential tasks confronting the expert who is entrusted with an examination. It is not the least reason for his appointment. From a mass of chaotic, often contradictory, assertions, he is expected to sift those which are based upon reality instead of upon prejudice. Although skill in discrimination is necessarily dependent upon experience, there are two safeguards, known as "checks," which will protect him from serious mistakes. These checks are contrasts with similar conditions and comparisons with similar periods. The routine in one factory may be contrasted with that in another. The production for one month may be compared with that for another. Such contrasts and such comparisons will accentuate any deviations from the norm and will lead an interviewer to question, and to study more closely, any development that seems exceptional. Under these circumstances, if the matter is important, he will naturally desire to have the conditions about which there is disagreement repro-

duced for observation. It is no exaggeration to say that one of the chief purposes of the interviews made in the course of the average examination is to discover discrepancies in the testimony of those who ought to be acquainted with the facts and to determine the tests required to establish the truth.

Function of the Questionnaire.—Although the questionnaire is becoming the great American nuisance, it is the source of valuable data in many examinations. In essence, it is nothing more than a series of questions, designed to collect information from a group of individuals, which has been duplicated or printed for distribution. Since an attitude of indifference is normally to be expected from any one who receives such a form, unless he is in duty bound to answer it, the writer ought to arouse as much interest in the recipient as possible. To this end the questionnaire should be accompanied by a covering letter or by a statement setting forth in a tactful and courteous manner the use to which the replies are to be put, thanking the recipient for his trouble in filling in the answers, and stating clearly that due credit will be given to those who furnish information or, if it is advisable, that secrecy will be maintained. To secure the fullest coöperation the questionnaire should be short and the questions as brief and simple as possible; so specific, in fact, that they can be answered by a check mark or a figure, and so clear that they cannot possibly be misunderstood. Quantities, measures, and terms sanctioned by practice should therefore be employed. In every other way, also, the burden of reply should be minimized. For this reason it is customary to furnish an addressed return envelope, of the stamped or "business reply" type, for the convenience of the recipient. With every precaution, the writer will usually be fortunate to receive back even half of his questionnaires properly filled in. If he is sure that his cross-section of replies is representative, he may, however, rely on the accuracy of percentages that are even lower.

Preparing the Mailing List.—If the questionnaire is to be sent to a selected group rather than to all those who might supply information, the method of sampling should be used.

The manner in which these individuals are chosen must be sufficiently diversified to allow full play to the element of chance and must be maintained consistently until the panel is completed. Since the technique of sampling has already been discussed, it will be sufficient here to point out that a system of chance selection is statistically sound and can be defended on logical grounds.

The method adopted by J. H. Leuba in collecting data for his monograph entitled *The Belief in God and Immortality* (Chicago, 1921) is typical in its variety and uniformity. In obtaining the views of numerous groups—scientists, sociologists, psychologists, philosophers, and historians—on the subject suggested by the title, he employed the arbitrary but nevertheless, regular system explained in the following quotation from a recent letter in the *Literary Review* of the New York *Evening Post:*

(7)

Take, for example, his use of *American Men of Science,* the scientists' *Who's Who,* which contains 5,500 names, of which 1,000 are "starred" for eminence. Professor Leuba took 600 names as representing the 4,500 that are not starred—whose bearers, that is, are not especially eminent; he chose 300 of them by taking the first name on every other page and the last name on every 15th page, and another 300 by a similar rule of chance. (In case one of the names so chosen was starred, he chose the first unstarred names preceding or following.) As representing the more eminent scientists, he took two groups of 200 each—each fifth starred name, beginning at the beginning of the volume and each fifth starred name, beginning at the end. This method is "arbitrary" in a sense; but the arbiter is chance, not Professor Leuba. And it is precisely upon the arbitrament of chance in the selection of instances that the value of any statistical generalization depends.

In his choice of scientists, Professor Leuba's method represents six distinct cross-sections of a large and influential group. Although his system of selection is, as his defender admits, subject to the law of chance, it is also, as he insists, statistically sound. A similar procedure, useful for comparison, is outlined on pages 212 and 213.

Form of the Questionnaire.—It is, of course, impossible to exemplify all of the forms assumed by the questionnaire. They are as various as the subjects with which it deals. There are certain conventions, however, which are common to them all.

Like a letter, every questionnaire must have a heading, which will establish contact between writer and recipient. This heading may consist of nothing more than a few lines of introduction. For instance, in preparing his first report to the President, the Director of the Budget submitted to the different departments of the federal government a number of questionnaires with an ordinary military heading:

FROM: Chief Coördinator, General Supply
TO: Director of the Bureau of the Budget
SUBJECT: Report for the Period August 1 to December 31

More often, however, where the relationship between the sender and the recipient is not close—that is, when the questionnaire is sent to a general group rather than to the members of an organization or association which already possesses information regarding the recipients—headings are arranged to elicit rather full information about the person or firm consulted. Two examples (8 and 9) will illustrate current practice.

In the preparation of the questionnaire, questions should be numbered consecutively, a practice which prevents confusion and which is useful in tabulating results. Adequate space should be provided for replies. Two general types of questions are to be found: those eliciting facts and those calling for opinions. In wording and arranging the questions it is well to observe certain usages. For instance, questions should be stated in such a form that replies will be capable of tabulation and facts should be presented in terms which are commonly understood and accepted. The blanks should be easy to fill in and should be properly spaced to contain the information desired. If possible, lines of type should be gauged to the intervals on a standard typewriter. Provision may also be made for check marks.

(8)

IOWA STATE COLLEGE
OF AGRICULTURE AND MECHANIC ARTS
Ames, Iowa

May 1, 19......

A STUDY OF ENGINEERING EDUCATION AT IOWA STATE COLLEGE

Questionnaire for Students in Residence

Date..............................

Course..............................

Class: Fr..... So..... Jr..... Sr.....

1. Name in full..............................
2. Permanent home address..............................
3. Other places you have lived, with years at each place..............................

....

....

4. Parentage:
   a. Father's nativity..............................
   (France, Holland, U.S., etc.)
   b. Mother's nativity..............................
   c. Father's education: Grade Sch......High Sch......College......
   d. Mother's education: Grade Sch......High Sch......College......
   e. Father's occupation: Past..............Present..............

(9)

FEDERAL EMERGENCY ADMINISTRATION
OF PUBLIC WORKS

Washington, D. C.
May 20, 1936

QUESTIONNAIRE

Regarding Pending Projects Recommended for Approval by Examining Divisions as of May 18, 1936

STATE

DOCKET NUMBER

LOCATION

TYPE OF PROJECT

LOAN

GRANT

TOTAL ALLOTMENT

ESTIMATED COST

Two illustrations (10 and 11) will suggest the usual practice in questionnaires devoted to facts.

From *Questionnaire Regarding Pending Projects Recommended for Approval by Examining Divisions as of May 18, 1936* (Federal Emergency Administration of Public Works):

(10)

1. Is an election required?
   Yes ☐ No ☐ Held............... To be held...............
   date date
2. Is legislation required?
   Yes ☐ No ☐ How long to pass..........................
3. Are applicants' funds available?
   Yes ☐ No ☐
   Source of funds....................................
   Where deposited ....

4. Are plans and specifications ready?
   A. Preliminary — Yes ☐ No ☐
   B. Final — Ready for bids Yes ☐ No ☐
   State percentage complete..........................
   Date when will be ready for bids....................

5. Within what period after allotment of funds could construction be started?................................
   State in weeks

6. Within what period after start of construction could project be completed?.................................
   State in weeks

7. What is the estimated average number of men to be employed on the site of the project?........................

8. What are the unemployment conditions at the present time in the locality of this project?

From the "Report of Subcommittee 14, Design of Indoor and Outdoor Substations," *Proceedings* of the American Railway Engineering Association for 1929:

(11)

A brief questionnaire was sent out in January, 1928, to 50 power companies and 37 railroads covering substation design elements as follows:

1. Operating voltage KV.
2. Number of phases.
3. Frequency—cycles.
4. Outdoor or Indoor.
5. Bus supporting structure:
   (a) Masonry.
   (b) Steel pipe.
   (c) Structural steel unit type.
6. Clearance—inches:
   (a) Phase to phase.
   (b) Phase to ground.
7. Insulation flashover value—KV:
   (a) Phase to phase.
   (b) Phase to ground.
8. Is system neutral grounded?
9. Remarks.[7]

[7] Reprinted by permission of the American Railway Engineering Association.

These questionnaires also illustrate another factor, that of length. As a rule the number of questions ought not to exceed ten. In fact, it is advisable to compress them, whenever possible, within the limits of a single page. If the recipient of a questionnaire finds that it extends over more than one sheet, he will probably feel that he is being imposed upon. If he can take it in at a glance, he is much less likely to toss it into his waste-paper basket. For this reason, it is always well to curtail the length. When twenty or thirty topics must be considered, it is better to send out two or three short questionnaires to as many cross-sections of a group than to send out only one. The results are likely to be much more satisfactory.

In asking for opinions there is danger that the investigator may so state his question that it will influence the recipient to reply as the investigator desires. A recent newspaper editorial has put the matter clearly: "There is growing need in modern America for a treatise on 'The Art and Science of the Questionnaire.' Skill in the use of this instrument of our times is becoming widespread. By means of questions aptly put, public opinion may be neatly registered in the terms of the inevitable answer. The United States Chamber of Commerce worked the business so well that local chambers found that the only way not to answer the questions just exactly as the United States Chamber wanted them answered was not to answer them at all." Such "leading questions" as the following from a questionnaire sent to manufacturers are, to say the least, not the sort that should be used by a scientific investigator preparing an unbiased study:

3. Will you work and vote for an early return to balanced governmental budgets?

8. Do you favor awarding governmental contracts to the lowest responsible bidder, in accordance with the law, instead of using contracts to compel acceptance by bidders of governmental policies not specifically provided for by law?

12. Do you believe in creating by law, through such measures as compulsory unemployment insurance, old age pensions, etc., a private right to publicly controlled funds,

thus reducing the efforts of individuals to provide for themselves and increasing their unwillingness to rely on the government for support, thereby aggravating the very evils which such legislation is intended to relieve?

Such questions remind one of the classic question of the attorney, "Have you stopped beating your wife? Answer 'Yes' or 'No.' "

Questions calling for opinion and discussion may be properly phrased so that the investigator will be reasonably sure of obtaining intelligent and unbiased answers, as is illustrated by Professor Kirkpatrick's questions to radio listeners, of which the following are samples:

10. Do you feel that, as a whole, programs are better ( ); the same ( ); or worse ( ) than a year ago? Please check your answer.
36. Do you think that chain programs on the whole improve the quality of broadcasting? Yes ( ). No. ( ). Please check.

A well-designed questionnaire containing questions of fact and of discussion and opinion is reproduced in part below from the *Proceedings* of the American Gas Association for 1931. Especially worthy of note are the definition of "service" to insure clearness, the careful subdivision and numbering of questions, and the adequate spaces for reply.

Some Necessary Considerations.—In connection with both the interview and the questionnaire, as has already been suggested, certain considerations regarding attitude, proportion, and point of view should not be overlooked. During no other part of the examination are accuracy and care in detail more essential. To demand substantiation of every statement, to advance step by step from the familiar to the unfamiliar, to take stock hour by hour, to analyze and to recapitulate—these are the fundamental principles.

In an interview especially, where an investigator is likely to be brought into intimate relationship with those whose interests and tastes may coincide with his own, he is apt to be drawn into

(12)

Name of Company .... Date...........
Address ....
....
Report by..............................

A. G. A. Appliance Service Questionnaire [8]

Service as mentioned in this questionnaire has to do with the installation, operation, maintenance, and remedying all complaints of various domestic gas appliances, but does not include items entering into the installation or maintenance of services, meters, and house piping.

1. How many domestic gas meters are on your lines..........
2. What is the square mile area of the gas territory which you serve ....
3. How many of the appliances are now on your lines:
   (give number of each)
   (1) Tank water heaters.....................
   (2) Automatic water heaters ....
   (3) Gas refrigerators ....
   (4) Gas house heating furnaces...............
   Other domestic appliances
   (5) ....
   (6) ....
4. How many service calls are made per year on all types of appliances ....
5. Do you segregate these calls ....
   If so, the following information is requested:
   (1) What are the classifications you use as to type of appliances such as water heaters, house heaters, refrigerators, etc. ....
   [Questions 2 through 6 omitted]
   (7) If you segregate expenses in any of the above ways, do you consider it advantageous ....
   What does it cost.................................
   What extra personnel is necessary..................
   ....
6. Do you give free service for various types of appliances....
   ....

[8] Reprinted by permission of the American Gas Association.

7. Do you charge for service to customers..................
Why ....
....
....
How much for each appliance............................
....
Describe service charged for............................
....
....
....

[Questions 8 and 9 omitted]

10. Please describe your plan for the education of
(1) The service man ....
....
....
(2) Your cooperative dealers, if any..................

[Questions 11, 12, and 13 omitted]

14. In your opinion, can the ordinary service costs be lowered by the employment of higher type service men................
(1) Could a special organization mentioned in 13 be eliminated by such a change ....

an attractive by-path and enticed from the highway altogether. He may even be enticed from it by his devotion to his work. Some men become so fascinated by minutiæ that they lose all sense of proportion. A couple of years ago a young engineer was asked to secure certain information for the head of a great corporation in one of the Eastern States. Losing himself in the intricacies of his subject, he finally presented a report of 300 typed pages. Since the maximum expenditure on the project to which it referred was to be $10,000, the comments on his judgment were far from flattering. Against such mistakes—which are reflected, of course, in both the interview and the questionnaire—an expert must be on guard. The maintenance of perspective is a burdensome duty.

There is also another danger. The specialist, who is accustomed to the discovery of recurrent conditions, will probably approach his task with certain preconceptions as to what he will find. As a result, there is always a possibility that these pre-

conceptions may affect his view of the situation which confronts him. In the same way, an expert who has been in the habit of dominating others is apt to impose his ideas on those whom he interviews or to so word the questions in his questionnaire that he is likely to secure the answers which he desires. To be on the outlook for defects and, if recommendations are in order, to suggest remedies—all this is the path of duty; but to maintain an attitude unwarranted by the facts, to be biased by personal views, to be blind to the obvious—this is fatal. Unchangeableness of purpose, earnestness in the pursuit of truth, and elasticity of temper are the handmaidens of success.

A Typical Examination.—How the technique which has been outlined in this and the preceding chapter—that is, the office work and field work required in the course of an examination—may be adapted to a particular problem may be illustrated by a review of the investigation of flood conditions at Columbus, Ohio, by John W. Alvord and Charles B. Burdick, of Alvord, Burdick and Howson, Engineers, of Chicago.

The City of Columbus, Ohio, is situated at the confluence of the Scioto and Olentangy Rivers. In the last week of March, 1913, it suffered from one of the most disastrous floods in the history of the United States. Four thousand homes were submerged; 20,000 people were trapped, and 93 were drowned. The disaster led to an immediate demand for the development of a scheme of flood protection.

On April 8, Messrs. Alvord and Burdick, who had been responsible for similar undertakings, were selected to study the situation. On May 4, they and the Mayor, the Director of Public Safety, the Director of Public Works, the Chief Engineer of Public Improvements, and others interested met in conference to discuss the aim and scope of the investigation. Next day their appointment was confirmed by the City Council. On May 16, they submitted to it a plan of action, which was approved on June 16. By the terms of the contract, they were to receive a definite sum, fixed in advance, for their services. All other expenses were to be borne by the City.

As determined by this agreement, the aim of the examination was to decide upon the practicability and cost of certain

projects dealing with the improvement of old and the construction of new channels, with suitable dams and reservoirs for storage purposes. The scope, it was settled, should include, so far as time permitted, a review of conditions in the past which might serve as a basis for prognostication. The procedure, outlined by the consultants, was based on a scheme of collaboration in which most of the field work was entrusted to Henry Maetzel, Chief Engineer of the Department of Public Improvements.

During the five months devoted to the examination, about 20 assistants at the Chicago office were engaged on different problems. With the members of the Department of Engineering in the Ohio State University and the staff of the City Engineer, between 50 and 75 men were constantly employed. Direction was divided between the two partners, Mr. Burdick handling economic questions and Mr. Alvord, engineering.

Though they were both familiar with the control of flood conditions, they turned at once to methods followed by other experts. As a result, three preliminary examinations appeared necessary:

1. A local reconnaissance based on interviews
2. A topographical reconnaissance based on the maps of the United States Geological Survey, and
3. A general reconnaissance based on personal observations

The first made clear the nature of the losses. The second indicated the points where detailed studies were advisable. The third proved especially important. On June 11, Mr. Alvord, Mr. Maetzel, and Professor Frank H. Eno, of the Ohio State University, left Columbus by automobile, crossed the Olentangy to the Scioto, and then proceeded north. At Marion, Professor C. E. Sherman, of the Ohio State University, took the place of Professor Eno. Everywhere they found precipitous banks; small frame houses which could be moved without difficulty or expense; and porous limestone formations likely to affect the construction of dams and reservoirs. Four sites were selected for further consideration.

In the meantime, records of various kinds had been consulted. Among these were the *Report on Sewage Disposal*

made to the Director of Public Improvements, May 1, 1898; the *Report* on the flood by the Ohio State Board of Health; the files of the United States Weather Bureau, and the files of the United States Geological Survey. In the meantime, also, certain legal opinions had been secured and the avenues to be followed in the final examination had been definitely determined. These were three:

1. Economic
2. Physiographic
3. Hydrological

The losses due to the flood fell into two distinct classes, direct and indirect. In general, only the first were considered. Both office work and field work were necessary. In the case of real property belonging to private owners, the examiners had to fix a ratio between assessed and true values through studies in tax returns and market transfers. Personal property losses to merchants and manufacturers were established by canvasses in company with officials familiar with local conditions. The values of public property such as streets and pavements were largely matters of record which could be secured without difficulty. As intimated, no attempt was made to estimate losses due to the interruption in the life of the City. There was, however, a shrinkage in bank clearings of more than $2,000,000 for the week of the flood. In addition, the railroads, to which questionnaires were submitted, placed their indirect losses at 60 per cent of the total amount. Some idea of the aggregate was therefore obtained.

Though it had been planned to examine the whole watershed of the Scioto and Olentangy Rivers, with a drainage area of 6,481 square miles, it was decided early in the investigation to exclude the lower reaches and to cover only the upper half, and especially the upper quarter of the watershed. Cross sections at intervals of one to three miles were therefore taken, over 150 miles of river. Favorable sites for reservoirs were definitely selected, and 50,000 acres in all were accurately plotted. In addition, channel sections at intervals of 50 to 100 feet were taken in Columbus. Test pits and borings were not uncommon.

In studying the hydrology of the district, various sources were tapped. Among these were newspaper files and local histories. Especially useful were the records of the United States Weather Bureau and the Geological Survey. The hydrographs formulated by reference to them were checked by estimates of the rainfall and run-off above the Waterworks Dam, where a gauge had been maintained since 1908; by observations made from time to time by Professor Eno, and by meter measurements made by students of the Ohio State University in connection with their courses. Some of the most interesting checks were due to a pattern maker, discovered by Mr. Alvord, whose recollections, well substantiated, reached back to 1872. By means of such studies, observations, and interviews, based, usually, on outlines furnished by the chief engineers, satisfactory data were finally collected.

CHAPTER 11

EXAMINATION REPORTS—PROBLEMS

Special Problems.—Since the problems of office work and field work in the preparation of examination reports have been considered thus far from a general point of view, the procedures outlined in them are applicable in most fields. Because reports are practical affairs, written about definite matters in answer to specific questions, it seems advisable to consider, at least in outline form and on the basis of the studies available, just what material goes into a report and how it may be most effectively arranged.

The following pages indicate the way in which the expert is accustomed to proceed in preparing an examination report [1] in a number of major fields. For much of this information the authors are indebted to many specialists, particularly to those whose names are mentioned later in this chapter. They have also drawn on the publications of various governments, private foundations, and universities.

Highway Systems.—The condensed outline [2] reproduced below illustrates the procedure to be followed and the material required in making a complete study of the highways in a limited area such as a county or a state. The publications of the Bureau of Public Roads, United States Department of Agriculture, contain many similar studies. Of special value are the surveys of state highway systems, such as those of California (1920), Connecticut (1926), and New Hampshire (1927), and of regions, such as the Region of Cleveland, Ohio (1928).

[1] Among sources of value as suggesting plans for conducting examination reports should be mentioned *Inspection of Fruit and Vegetable Canneries*, United States Department of Agriculture *Bulletin* 1084, by F. B. Linton, which contains an excellent synopsis of a report on a pea cannery.

[2] Prepared by Edward R. Cary, Professor Emeritus of Road Engineering in Rensselaer Polytechnic Institute.

(1)

OUTLINE

I. SCOPE

II. CLASSIFICATION OF ROADS

III. TRAFFIC CENSUS

1. History
2. Purpose
3. Method
    - A. Locations of traffic stations
    - B. Frequency and duration of counts
    - C. Classification
    - D. Tally sheet
    - E. Field weighings
4. Use (of most value when system is improved)
    - A. Track profile
    - B. Traffic map
    - C. Relation of volume of traffic to condition of constructed road
    - D. Determination of width and capacity of roadway
    - E. Peak loads on the highway
5. Economic survey (of particular value with unimproved roads)
    - A. Analysis of transportation needs of industries, urban and rural
    - B. Central sources of traffic
6. Vehicle registration

IV. ECONOMICS

1. Cost of transport
2. Economic values of highway relocation
3. Increase in property values

V. ADMINISTRATION

1. Organization
2. Program of construction
3. Construction by whom
4. Control of traffic
5. Trail marking
6. Cost accounting

VI. Finances
  1. Income of county
  2. Bonded indebtedness
  3. Money available
  4. Methods of financing construction and maintenance

VII. Surveys

VIII. Design
  1. Present system: surface, topography, etc.
  2. Alignment
  3. Subsoil studies
  4. Base course
  5. Surface
  6. Cross-section
  7. Loads
  8. Volume changes
  9. Reinforcing
  10. Guard rails and other road accessories

IX. Construction
  1. Drainage
  2. Grading
  3. Study of available materials . . .
  4. Road surface
  5. Time to elapse after completion before use
  6. Inspection and making tests; instructions to inspectors
  7. Cost accounting

X. Maintenance

XI. Map of the County, Showing:
  1. All present roads, types shown by different colors
  2. Classification of roads shown by letters
  3. Cities and villages
  4. Special industries
  5. School houses
  6. Locations of steam and electric railways
  7. Locations of local supplies of road materials and the places of their delivery from outside sources
  8. Locations of streams and bridges
  9. Locations of water supplies for construction and maintenance
  10. Programs for sequence of construction.

It is sometimes necessary to prepare a report on the valuation of a highway system. The outline reproduced below[3] in modified form illustrates the method of preparing such a report:

(2)

OUTLINE

1. Complete inventory of all highway property units and age groups of like units
2. Value of land owned and used
3. Original cost new including overhead construction costs, less total depreciation to date of present physical property units except land
4. Reproduction cost of these units
5. Total present physical value
6. Intangible values, such as
   (1) Preliminary expense value
   (2) Going concern value
   (3) Highway easements over lands used but not owned
7. Working capital required to operate the system
8. Earning value or net return, which is total revenue minus operating costs, minus annual depreciation
9. Service-worth value, determined by
   (1) Traffic surveys
   (2) Reasonable worth per unit of each class of highway service
      (a) Road access service
      (b) Road use service

Public Service Corporations.—The outline below[4] is a fairly comprehensive chart for the investigation of public service corporations already existing. Section VI also provides a basis for the study of power sites; and the first five and the last five sections may be used for a survey of any organization which serves the citizens under the public franchise.

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[3] Modified from "Process of Making an Engineering Valuation of a Highway System," by Anson Marston, Dean and Director of Engineering, Iowa State College, in the *Proceedings* of the Thirteenth Annual Meeting of the Highway Research Board (1934).

[4] Prepared by Ralph U. Fitting, of Parsons, Klapp, Brinckerhoff and Douglas, New York City, and reprinted (II, 341-347) from *Language for Men of Affairs* (Ronald Press, New York, 1920).

(3)

OUTLINE

I. SCOPE
   1. General discussion of character of report
   2. Business and character of company
   3. Cities, towns, and counties served

II. DISTRICT SERVED
   A. History of territory
   B. Location
      1. Detailed description of territory served, showing towns by maps as exhibits
      2. Reasons for growth of city and territory
      3. Special industries and developments tributary
   C. Population
      1. School enrollment by years of each place considered
      2. Population at census date, with figures in brackets, to indicate per cent of increase
      3. Discussion as to probable future growth and estimate of population by years
   D. Transportation
      1. Names of railroads, also names of branches
      2. Steamship lines, names and routes
      3. Discussion as to terminal facilities, dockage, harbor, and future growth
   E. Industries
      1. List of industries into groups of same kind, giving individual capacities, number employees, pay-rolls, etc., or whatever unit will be comparable, or indicative of size
      2. Future industries, growth of enterprises in district and discussion as to character
   F. Banks
      1. Clearing-house statements by years
      2. Total bank deposits by years
      3. In appendix, list of all banks and trust companies with bank deposits segregated
   G. Post-office receipts [comparative, by years]
   H. Assessed valuation. Comparative assessed valuation of cities, also tax rate

I. City indebtedness
   1. List total bonds outstanding by years
   2. In appendix, list showing each issue giving date issued, term, rate, amount and for what issued

J. Building permits
   Number and value of all permits issued by years

K. Newspapers
   Names and reported circulation

L. Water supply
   1. Discussion as to source
   2. Service, whether privately owned or by city

M. Summary
   1. Discussion on prosperity, past and future, of territory or cities served
   2. The effect of such prosperity on the company

III. Competition

Complete discussion of competing companies, giving following information:
   1. Capitalization and bonded indebtedness
   2. Principal owners
   3. Franchises (copy in exhibit)
   4. Principal contracts and character of all business done
   5. Standing with the community and relation to company

IV. History and Organization
   1. Short history of company leading up to present organization with names of underlying companies, capitalization, and dates of transfers
   2. Discussion of company's charter giving date granted, term and unusual features
   3. Capitalization and chart showing relationship of companies

V. Franchises
   1. Abstract of each franchise owned giving essential points
   Copy in appendix
      (a) Perpetual
      (b) Indeterminate
      (c) Limited

2. Discussion as to opinion of attorneys, attitude of city officials, probability of renewal, etc.
3. Street railway franchises on street

VI. Hydrology

A. Location of drainage area
   1. In relation to well-known geographical landmarks
   2. Names of tributaries and area of drainage in square miles
   3. As to shape and size
   4. Location of area in relation to path of storms or moisture-laden trade winds

B. Drainage area
   1. Geological history of formation and character of exposed materials
   2. Whether materials are pervious or impervious
      (a) If pervious, whether
         Shallow or deep;
         Level or inclined;
         Outlet is in some river or into valleys of other rivers
   3. As to condition of stream bed, whether pervious or impervious, whether bed contains deposits of gravel permitting extensive underflow
   4. Condition of surface
      (a) Whether bare or covered with vegetation
      (b) Whether in natural condition or cultivated
      (c) Nature of vegetation, whether grassland, cultivated crops or forests
   5. Topography of surface
      (a) Whether level or inclined
      (b) Character of surface whether smooth or rugged

C. Character of stream and its tributaries
   1. As to shape or gradient
   2. As to falls and rapids on stream
   3. As to section of stream whether deep or shallow
   4. As to arrangement of tributaries, nature and extent of surface storage—lakes, ponds, marshes

5. Nature and extent of ground storage, consisting of gravel, sand, etc.

D. Precipitation
1. Whether it occurs as snow or rain
2. The amount of each and total
3. Its distribution throughout the year
4. Its intensity and manner of occurrence
5. The character of storms, including their direction, extent, and duration

E. Temperature
1. Variations of temperature on the area
2. Relation of extreme temperature to the occurrence of precipitation
3. The accumulation of snow and ice caused by low temperatures and effect on stream-flow
4. Occurrence of low temperatures causing the freezing of the ground surface at times of heavy spring rains, resulting in excess run-off

F. Stream-flow
1. Hydrographs
2. Relation of stream flow to run-off

G. Artificial control of stream
1. As to dams and storage reservoirs on drainage area
2. As to restrictions of the river sections by dykes and levees
3. As to obstruction of the stream by piers, abutments, etc., into waterway

H. Artificial use of stream
1. For irrigation
2. For water supply
3. For supply to navigation canals
4. For artificial storage and regulation of same
5. Stream-flow in terms of available power

VII. Physical Property

A. Outline of physical property owned by the company

B. Detailed description of property
1. Real estate with description in brief of each parcel showing location as to important centers

2. Buildings, general dimensions and one-word description of type of construction
3. Generating equipment, by sizes, type, speed, etc.
4. Transmission system
5. Sub-station equipment
6. Distribution system
   - Poles
   - Wire
   - Transformers
   - Meters
   - Arc lamps
7. Office furniture and fixtures

VIII. FINANCIAL

A. Earnings and expenses

Statement as derived from company's books, with correction to standard systems of accounting, if necessary, or from an auditor's report. This should be by years for each department, showing also interest charges, depreciation, reserves, etc., and the surplus applicable to stock.

B. Bonds

Underlying issues and digest of mortgages, and secure copies for files

C. Balance sheet

Latest balance sheet with discussion of each item
Also comparative balance sheet in appendix

IX. DUPLICATION VALUE

A. Estimated replacement value by Washington method with depreciation of each part shown in tabulated form, including supplies on hand

B. Show equity of depreciated value applicable to stock

X. CONTRACT AND RATES

A. List in appendix either copies or abstracts of all contracts for whatsoever purpose

B. Rates to customers and discussion as to principal on which based and probable effect for all classes of business

C. Discussion as to special rates, etc., also list of customers with special rates with unit return and percentage of gross earnings

D. Suggestions as to improved rates and enforcement

XI. Operation
- A. Books of accounts, manner of keeping, auditing, etc.
- B. Annual pay-roll for operation only, showing per cent it bears to total gross earnings
- C. Annual maintenance and per cent it bears to gross earnings. Discussion as to neglect, etc.
- D. Suggestions for improvements in operation
- E. Load curve. Maximum daily output
- F. Earnings and expenses per unit

XII. Management

List of officers, with location and salaries
Discussion as to fitness

XIII. New Business
- A. Study of power business with tabulation showing kind of business, estimated connected H.P., estimated demand K.W. Estimated yearly revenue, year connected. Estimated cost to connect
- B. Increase in old customers showing percentage increase in each class

XIV. Improvements
- A. Capacity of apparatus and estimate of time when additions will be required
- B. Capacity of reservoirs and estimate of when more storage will be required
- C. Extensions to distributing systems
- D. To take care of new business

XV. Estimated Earnings
- A. Estimated earnings by separate departments with discussion of reasons
- B. Estimated operating expenses
- C. Net from operation
- D. Bond interest, etc.
- E. Surplus, and per cent it bears to stock

XVI. Summary and Conclusions
- A. Points of advantage
- B. Points of disadvantage, both as relating to:
  1. Population served and growth of district
  2. Condition of franchises
  3. Physical condition of property

4. Duplication value
5. Expenditures to be made
6. Estimated earnings and return on bonds
7. Recommendations

Timber Properties.—Among the most obvious examination reports are those which deal with timber properties. Because of the character of these properties, those who are interested in (1) their value or (2) their development must necessarily rely upon the information obtained for them by specialists.

In a comprehensive report on a timber property there are three main elements:

1. Text
2. Cruise sheets
3. Maps

Reproduced below are portions of the text and one cruise sheet of a report[5] prepared for a group of lumbermen in Chicago.

(4)

REPORT

ON

SECTIONS 7, 9, 18, 20, 21, 28, 29, and 33, Tp. 3: SECTIONS 4, 9, 10, 12, 13, 14, E. ½ 21, E. ½ 22, N.W. ¼ 25, S. ½ of S.W. ¼ 26, 35 and 36, Tp. 4: SECTIONS 1, E. ½ 2, E. ½ 11 and 12, Tp. 5; N.W. ¼ 6 and W. ½ 7. Tp. 6.

BIG BEND, COLUMBIA RIVER, KOOTENAY DISTRICT, BRITISH COLUMBIA

GENERAL DESCRIPTION

The tract under consideration is the central and northern portions of a large block of Crown Granted timber lands, located on the Columbia River about sixty miles north of Revelstoke in the Province of British Columbia. The tract itself contains portions of twenty-seven Sections, with a river frontage of about twenty miles, and an area of 13,504 acres.

The ground on a large part of this tract is fairly flat, with gentle

[5] Prepared by Judson F. Clark and P. L. Lyford, of Clark and Lyford, Limited, Forest Engineers and Timber Factors, of Vancouver, British Columbia.

slopes towards the Columbia River and its tributaries. The largest flat areas extend along the river and are from ten to forty chains in width. The slopes are fairly steep in places, but a number of benches break the surface at irregular intervals. The elevation of the Columbia River through this tract is slightly less than 1,800 feet above sea-level. In the distance of approximately fourteen miles through the tract, the change in elevation is less than forty feet. Usually the ground gradually rises up from the river flat and is fairly free from rock outcrops except through parts of Section 4, Township 4, where the slopes are excessively steep and rocky bluffs occur. The highest points above sea-level (approximately 4,000 feet) are located along the east boundaries of Sections No. 21 and 28, Township 3, and the south boundaries of Sections 10 and 12, Township 4. This is about 2,200 feet above the Columbia River. Big Mouth Creek is the largest tributary to the Columbia in this vicinity. It flows in a westerly direction through Sections 12, 13, 14, and 15, emptying into the river near the northwest corner of Section 15. The surface conditions for the Big Mouth Valley are good; the slopes are easy and free from any steep pitches for the first half-mile back from the stream. The slopes on the south half of Sections 10 and 12 are smooth but very steep.

Nearly the whole area is timbered, but the density of the stand varies widely in different parts of the tract, as shown by the colored type subdivisions on the maps. There are a few small areas in these different Sections containing no timber of merchantable value. Some heavy stands are located in the Big Mouth Creek Valley. The Cedar is large and of excellent quality, although considerable hollowness was noted. On the west side of the Columbia, the Cedar is smaller in size and appears to be fairly sound. On the extreme high elevations, the stands are lighter, with Spruce predominating.

The stands consist chiefly of Cedar, Spruce, Fir, Hemlock, White Pine, Balsam, and Cottonwood in the following proportions: Cedar 73.2%; Spruce 16.1%; Fir 4.2%; Hemlock 3.3%; White Pine 1.6%; Balsam 0.9%; Cottonwood 0.7%. The Cedar is the most important species, being found nearly everywhere on the timbered areas. Spruce occurs intermixed with the Cedar stands and in some places forms the bulk of the stand. The Fir and Hemlock are found scattered through the Cedar and Spruce stands. The Pine, like the Fir and Cedar, is found scattered through the other species, only in smaller quantities. Balsam and Cottonwood are found only on certain parts of the tract.

THE MAPS

The maps accompanying this report are on a scale of eight inches to the mile, with contour interval (i. e., the vertical distance between contours) of fifty feet. Every fifth contour line is drawn heavy and labelled with a figure indicating the elevation in feet above sea level.

Areas on which the stand is composed entirely of a single species occur, but the stand more commonly comprises a mixture of two or more species. These varying mixtures of the different species form distinct forest types over the tract. In determining the boundaries of these natural forest types, the density of the stand per acre is the controlling factor. Within the boundaries of any type as mapped there are places where the stand differs in density from the *average* given for the type, but these areas are not sufficiently large or distinct to justify further subdivision.

The boundaries of the forest types are indicated by dotted black lines. The type symbol (in a small circle within each type) shows the density of the forest types. (See legend on maps.)

In order to differentiate the timber types more readily to the eye, the maps have been tinted according to a standard color scheme, the three shades of green indicating the heavier stands. All types cruising 5 to 15 M feet per acre are tinted orange, and the types cruising less than 5 M feet per acre are tinted yellow.

The tracings of the maps are as complete in every respect as the colored maps except for the facility with which the different types may be recognized by virtue of the tinting.

THE CRUISE

The field work for this report consisted of running a traverse along the Columbia River for a main base line and rechaining the back boundaries for base lines. Tie-points for cruising were established along all base lines.

Cruise lines were run at ten-chain intervals, or twice through each forty; i. e., a two-run cruise.

The accompanying cruise sheets give full details regarding the stand of timber on the different forties. These figures refer to sound wood only, with a proper allowance for unavoidable breakage in falling. The cruise sheets show for each Section:

1. The amount and kind of timber on each forty cruising 5 M feet per acre and over.
2. The total of each kind of timber and the total by size classes for each species.

TIMBER CRUISE

OF

SECTION 7, TP. 3, BIG BEND, COLUMBIA RIVER, KOOTENAY DISTRICT, BRITISH COLUMBIA
M feet B. C. Rule in trees 10 inches and up in diameter breast-high

Forty Number	Acres in Forty	Fir 20" +	Fir 10–19"	Cedar 20" +	Cedar	Cedar 10–19"	Hemlock 20" +	Hemlock 10–19"	Balsam 20" +	Balsam 10–19"	Spruce 20" +	Spruce 10–19"	Pine 20" +	Pine 10–19"	Totals
1	50	50	..	240	..	64	170	42	..	..	60	..	..	..	626
2	50	182	2	174	..	43	72	48	..	..	23	6	28	..	578
3	50	127	7	126	..	65	90	42	..	7	148	31	120	..	763
4	61	7	2	290	7	9	78	17	6	..	379	2	..	..	797
5	46	..	..	146	..	12	5	4	25	16	290	20	..	..	518
6	40	80	2	118	..	35	25	15	5	..	193	23	39	..	535
7	40	123	1	82	..	34	15	25	..	1	180	21	7	..	489
8	40	111	..	153	29	47	5	20	..	..	66	8	24	..	463
9	40	126	..	318	..	37	50	32	..	..	130	2	15	..	710
10	40	62	..	404	..	28	56	16	..	2	214	12	..	..	794
11	40	..	..	149	6	11	..	7	10	8	347	20	..	..	558
12	43	..	..	29	..	2	6	..	..	14	295	29	..	..	375
13	41	..	..	92	..	..	23	..	26	43	286	50	24	..	544
14	40	..	..	562	..	13	..	..	11	8	377	15	..	..	986
15	40	..	..	994	..	10	..	..	..	..	136	5	..	..	1,145
16	40	89	..	488	..	47	36	3	..	..	142	..	..	..	805
Totals	701	957	14	4,365	42	457	631	271	83	99	3,266	244	257	..	10,686

Total in trees 20" and up (diam. breast-high) 9,601 M ft.

CLARK & LYFORD, FOREST ENGINEERS, LTD.
per J. E. TUCKER

July, 1922.

The following is the summary of the cruise for the tract in M feet B. C. Rule of all trees 10 inches and up in diameter breast-high:

	20″ and Up	10″–19″	Total	Per Cent
Fir	11,486	370	11,856	4.2
Cedar	191,085	13,997	205,082	73.2
Hemlock	6,263	2,989	9,252	3.3
Spruce	41,081	3,923	45,004	16.1
White Pine	4,337	23	4,360	1.6
Balsam	1,173	1,399	2,572	.9
Cottonwood	1,813	228	2,041	.7
Totals	257,238	22,929	280,167	100.0
Per Cent	91.8%	8.2%	100%	

Logging Conditions

[Described in detail.]

Markets

Damage

[Described in detail.]

Future Growth

Agricultural Industries.—Establishment of agriculture as an industry has produced a demand in this field for the kinds of reports which are current in other industries. Of these reports, those containing analyses of the condition of particular properties are among the most common and the most valuable. The outlines below [6] indicate, first, their variety and scope and, second, the procedure in and a plan for a report on a particular farm property.

(5)

Types of Investigations in Agriculture

The following studies were conducted in the course of a single year by the Department of Agricultural Economics of the Ontario Agricultural College:

[6] Prepared by Archibald Leitch, President of Windham Plantations, Limited, and St. Williams Plantations, Limited, and formerly chairman of the Canadian Marketing Board.

I. PRODUCTION

1. Surveys, three to five years in duration, of the five common types of farming found in six different districts in Ontario.
2. Detailed cost accounts, still current, for one year to four years, of twenty-five selected farms for each of four types of farming in Ontario.
3. Investigations of the cost of milk production in fluid milk areas tributary to Toronto.

II. MARKETING

1. The distribution of fluid milk in Ontario.
2. The distribution of the Ontario apple crop. Production and marketing studies in the case of cheese and butter have been conducted simultaneously.

III. TRANSPORTATION

1. An examination, for the different live stock interests, of the freight rate adjustments for live stock, with preparation of detailed cases for the Board of Railroad Commissioners.
2. An examination, now proceeding, of the express rate adjustments for fruit, with preparation of detailed cases for the Board of Railroad Commissioners.

OUTLINE

I. SCOPE

1. Character of report
2. Location and general description of property

II. HISTORY

1. Source of title and subsequent transfers
2. Character and time of settlement of district
3. Changes in type of farming of district
4. Time of clearing and first cultivation of property
5. Changes in type of farming on property
6. Changes in crop yields
7. History of buildings
8. Owner operation and tenancy

III. DESCRIPTION OF PROPERTY

1. Size and shape
2. Contour of land

3. Soil type
4. Acreage cleared
    (a) For plough
    (b) For pasture
5. Acreage wild
    (a) Fit for pasture
    (b) Woodland pasture
    (c) Woods
    (d) Swamp
    (e) River, stream, lake, or pond
    (f) Quarry or gravel pit
6. Water supply
    (a) For domestic and live stock uses
    (b) For grazing
7. Drainage
    (a) Natural
    (b) Artificial: open and closed
8. Fences
    (a) Kinds by rods
    (b) Condition
    (c) New needed at once
9. Buildings
    (a) House; size, material, condition
    (b) Main barns
        (1) Size, style, material, condition
        (2) Distribution of stabling
        (3) Description of stabling
    (c) Other out-buildings; size, material, condition; specific use
    (d) Plan or outline of buildings; locations on property
10. Implements (list and value all equipment)

IV. Operation

1. Crops (all data for three consecutive years)
    (a), (b), etc. Acreage and yield per acre of each crop tabulated, including fruits and tree products [7]
    (e) Sales (volume and percentage of total production) [7]

[7] Forms for preparing inventories such as those suggested may be obtained from the various state and national departments of agriculture.

(f) Crop yield index (compared with district averages)

2. Live stock
   (a), (b), etc. Tabulated data by kinds (specific breeds noted in all cases)[7]
   (e) Sales of live stock products[7]
3. Miscellaneous sales and receipts
   (a) Labor or team work off farm
   (b) Machine work
   (c) Other receipts
4. Analyses of receipts
   (a) Total receipts including change in inventory in live stock
   (b) Distribution percentage
      (1) Crop sales—relative to optimum
      (2) Live stock—relative to optimum
      (3) Miscellaneous
   (c) Receipts for tillable acreage
      For approximation of tillable area:

1	acre	tillable land	= 1	acre
3	"	cleared pasture	= 1	"
10	"	woods "	= 1	"

5. Current expenses
   (a) Tabulated data
   (b) Analyses of current expenses
      (1) Expenses per tillable acre
      (2) Feed bought (relative to amount grown)
      (3) Crop acres per man
      (4) Crop acres per work horse
6. Infestations of plant and animal disease
   (a) Rusts, smuts, blights, and insects in crops
      (1) Present evidence and severity
      (2) History of past infestations
      (3) Efficiency of control measures used
   (b) Abortion, tuberculosis, anthrax, cholera, and roup
      (1) Present evidence and severity
      (2) Past infections
      (3) Tests for discovery in use
      (4) Efficiency of control measures used
7. Books of account: form, manner of keeping, auditing, etc.

V. Valuation and Distribution of Capital
1. (a) Market value of real estate
   (b) Cash to run farm
   (c) Value of live stock
   (d) Value of implements
2. Mortgages and liens
3. Relation of proportion of each item of investment to optimum

VI. Recommendations
1. As to changes in crop, policy, and rotation
2. As to improvement in live stock
3. As to labor management
4. As to permanent improvements
5. As to better quality of product
6. As to possible developments in local marketing, facilities, dairy factories and depots, fruit packing houses, canning factories, etc.
7. As to growth and participation in coöperative marketing projects
8. As to refinancing capital obligations

Chemical Industries.—Of reports in the chemical industries, three of the four varieties—analytical, bibliographic, engineering, and research—are considered below. The research report will be treated in a later chapter. The following summaries [8] suggest not only the nature of the problems in each field but also a synopsis of the material which should be included in the report itself.

(6)

Analytical Reports

The materials with which the chemical analyst has to deal may be divided into two classes. The first includes naturally occurring and manufactured articles of which he is to determine the composition and regarding which he is to advise as to the value and adaptability to a given purpose, or to certify as to the presence or absence of deleterious substances or adulterants. Work of this nature ordinarily comes in the province of the consulting analytical chemist or commercial analyst. In the second class belong the raw mate-

[8] Prepared by W. A. Hamor, Assistant Director of the Mellon Institute of Industrial Research in the University of Pittsburgh.

rials and indeterminate, final, and waste products of industrial processes, for analysis of which provision is made in the way of special laboratories adjunct to the plants. Assaying, or the testing of metals, alloys, or ores in order to ascertain the quantity of gold or silver or any other metal present in them, may likewise be either consultative or in the plant.

The consulting chemist usually follows this general order in reporting the results of an analysis: brief description of material, including its source and the purpose of examination; tabular statement of analytical results; and then, if desired by his client, an interpretation of the findings, with especial reference to economic aspects. All analytical reports are brief and simple in scope, and in works laboratories it is a general practice to transmit analytical results on printed forms, employing the official nomenclature of the laboratory in describing materials.

Bibliographic Reports

This class of reports embraces general summaries of existing knowledge of a specific topic and critical reviews of the literature —text-book, periodical, and patent. Such reports are usually prepared by specialists in chemical bibliochresis for the guidance of research or for use in patent litigation.

The best-known form of report of this class is the annotated bibliography, in which the title of and complete reference* to each book or paper listed chronologically is followed by a brief précis of its contents. An annotated bibliography is preferable to a mere list of titles, but the abstracts should be skillfully prepared and should emphasize the parts of the publications listed that are particularly pertinent to the subject under consideration. A list of available American bibliographies is kept by the National Research Council, Washington, and this list should be consulted before surveying the literature of a subject. Perhaps the topic has been covered bibliochretically by another chemist, and a copy of his report, if not published, may be secured for temporary use.

Another type of bibliographic report presents in its text the results of a critical study of the literature of a subject. The information is usually arranged in chronological order and its bearing on the topic under consideration—a research proposal or a patent case —is indicated throughout and is summarized concisely at the beginning of the report. The general style followed in the text of

* The standard periodical list of the American Chemical Society should be followed in abbreviating the names of technical journals (see *List of Periodicals Abstracted by Chemical Abstracts* in the issue of November 20, 1936).

such a report is illustrated by the introductions of recent research reports published in the *Journal of the American Chemical Society* and *Industrial and Engineering Chemistry*. It is considered a good rule in many research laboratories to have each chemist who is getting ready to undertake a new piece of work submit a report on his plans for investigation and on what can be found in the literature on the subject before he actually begins experimental work. Then later, when the full report of the finished research is prepared, the bibliographic report may be used as the basis for the introduction in the manuscript.

CHEMICAL ENGINEERING REPORTS

Chemical engineering reports cover a big field. They may relate to problems in the design, erection, and equipment of chemical plants, to the investigational results of studies of new processes or products, or to appraisals of the values of plants, processes, or products. It is plain that many reports of this general class are economic in character, and therefore consideration should be given to the fact that they may be used by business men and others who know few technical words. In these reports stress should be placed on those chemical and physical facts that are of direct economic interest. Material that is principally of scientific or theoretical value and that has no direct bearing on the economic problems discussed should be omitted from such reports and reserved for possible future publication.

Reports pertaining to the design, erection, and equipment of chemical plants should follow the form generally accepted.[9]

Reports relating to the development of new processes or products should follow the outline advised for research reports. It may be necessary, however, for the sake of clarity, to divide the experimental part into several sections; viz., laboratory or preliminary investigation, unit-plant work, and factory operations—provided, of course, that the development work has gone beyond the laboratory stage.

Appraisal reports should be prepared in accordance with standard engineering practice. The following subject order is followed by some outstanding chemical engineers:

SUMMARY.—An abstract of the report.

INTRODUCTION.—Character and purpose of the appraisement, conditions under which work was done, and acknowledgments.

[9] See Chapter 13.

GENERAL DESCRIPTION OF PLANT,* including features.†

ECONOMIC CONSIDERATIONS.—Location, maintenance, outlay, income, equipment, possible improvements, competition, and future possibilities.

VALUATION.—Exchange value and productive value.

CONCLUSIONS, including recommendations.

* Or process, or product.
† Novel processes, equipment, etc.

Specific Industries.—The following outline, based on a number of sources, covers the main topics to be studied in the survey of a particular industry. The generalized headings will, of course, be adapted to textiles, iron and steel, rubber, machinery, or any other of the 331 classes of manufactures included in the census of manufactures.

(7)

OUTLINE

I. INTRODUCTION
   1. Purpose, scope, and character of report
   2. Type of business or factory

II. CITY WHERE PLANT IS LOCATED
   1. Form of government
      (a) Political situation
      (b) Taxation policies
   2. Accessibility
   3. Climate
   4. Transportation facilities, by water, rail, highway, and air, including terminals
   5. Other industries
   6. Statistics of the city
   7. Civic organization

III. COMPANY ORGANIZATION; AFFILIATIONS
   1. Management chart
   2. Officers and directors
   3. Management, including holding company relationships
   4. Offices and sub-offices

IV. HISTORY AND REPUTATION OF COMPANY
   1. History of development
   2. Relation of company to city officials

3. Integrity of present management or owners
4. Business sources, credit problems, selling problems, etc.
5. Quality and reputation of product

V. PLANT

1. Location
2. Description of real estate
   (a) Area
   (b) Ownership
   (c) Mortgages
3. Buildings (including general layout)
   (a) General description
   (b) Main buildings and collateral buildings, sizes and areas covered, floor-space
   (c) Type of construction
   (d) Ventilation, heating, lighting
   (e) Facilities for employee comfort, such as lockers, lavatories, restaurants, library, etc.
4. Machinery and equipment (list by departments in appendix)
   (a) Machinery
      (1) Type
      (2) Number of machines
      (3) Age, condition and depreciation, modernity
      (4) Special equipment
      (5) Adaptability; changes and flexibility of units
   (b) Power plant
      (1) Boilers and auxiliaries; kind and condition
      (2) Prime movers and type of power
      (3) Fuel or power-supply
   (c) Water
      (1) Sources
      (2) Character
      (3) Treatment
   (d) Waste disposal
      (1) Character of waste
      (2) Facilities for disposal
      (3) Treatment problems

VI. Production

1. Brief description of the process (illustrated)
2. Routing of material by items, with layout
3. Planning and control, efficiency programs
4. Inspection and tests
5. Packing

VII. Employees and Labor Situation

1. General statement, classifications
   - (a) Supply, location, and amount
   - (b) Nationality, character
   - (c) Average age
   - (d) Sex
   - (e) Average length of employment
2. Turnover analyzed
3. Labor difficulties
4. Form of government
   - (a) Open-shop
   - (b) Company union
   - (c) Coöperative
   - (d) National unions; type and management
5. Strikes, with dates, length, cause, and settlement
6. Wages and rates of pay
7. Piece-work schedules
8. Living conditions
   - (a) Company quarters
   - (b) Private homes
   - (c) Transportation
9. Personnel work
   - (a) Workmen's compensation
   - (b) Safety work
   - (c) Unemployment insurance; hospitalization
   - (d) Pension system
   - (e) Community activities: health schools, adult education, club and recreational activities

VIII. Materials of Fabrication

1. Product materials by items
   - (a) Quantities and average prices
   - (b) Sources of supply
   - (c) Transportation
2. Supplies in production: lubricants, chemicals, tools, etc.
   - (a) Quantities and average prices
   - (b) Sources of supply

IX. Financial
1. Condensed balance sheet
2. Earnings statement by years
3. Profit and loss statement by items
4. Manufacturing cost by items
5. Taxes, insurance, miscellaneous
6. Contracts

X. Valuation
1. Duplication value of plant and real estate
2. Depreciation rates and formulas
3. Estimated going value

XI. Quality and Reputation of Product

XII. Marketing
1. Market for products; sales technique
2. Diversity of sales
3. Fluctuations in demand
4. Sales prices, with tables
5. Future prospects and trends
6. Market research work

XIII. Competition
1. Location of principal competitors
2. Nature of competition
3. Future trends
4. Effect of governmental restrictions
5. Effect of world trade situation

XIV. Recommendations

With modifications this outline can be adapted to, for instance, the mining and petroleum industries, in which case it will include consideration of titles, geology, supply reserves, treatments, and other problems; and to the transportation industries, in which case it will include consideration of the character of revenue-producing goods, nature of travel, terminal problems, inventory of rolling-stock or vessels, and the like. Indeed, as already indicated, it will serve as a foundation for many types of industrial examination reports.

Organizations.—The following outline, somewhat shortened from the original form,[10] indicates the scope and nature of a

[10] Prepared by C. E. Knoeppel and Company, Industrial Engineers, and reprinted (II, 354-362) from *Language for Men of Affairs* (Ronald Press, New York, 1920).

report on an organization from the point of view of its efficiency as a working unit. The scheme suggested may be used to study conditions in any establishment.

(8)

1. Institution Investigated
2. Date of Investigation
3. General Description of Institution
   (a) Nature of organization
   (b) Officers or members of firm
   (c) Nature of business
4. Interest Held by Officers (or Members)
5. Outline of Duties of Officers
6. General Policy of Management
   (a) As to personal duties
   (b) As to knowledge and contact with details
   (c) As to methods of handling departments
   (d) As to recognizing progressive methods
   (e) As to use of actual reports of results
7. General Offices
   (a) Arrangement
   (b) Facilities; light and cleanliness
8. Plant
   (a) Arrangement in general
   (b) Arrangement as to efficiency of production
   (c) Arrangement as to care of materials
   (d) General appearance
9. Product Manufactured
   (a) In general
   (b) Stability of product as affects equipment
10. Labor Conditions
   (a) Union, non-union or open shop
   (b) Class of wages paid
   (c) Future possibilities of labor trouble
11. Liability Conditions
   (a) How insured
   (b) Safety precautions taken
   (c) Facilities for examination of applicants

(d) Facilities for care of injured
(e) Investigations of accidents
(f) Position of foreman on safety work

12. Fire Conditions and Risk
    (a) How insured
    (b) How well insured
    (c) Precautions taken
    (d) Protection against fire
    (e) Probabilities of result of fire

13. Employment of Help
    (a) How employed
    (b) Standards demanded
    (c) Extent of inquiry into past work
    (d) Extent of inquiry into dependents
    (e) Extent of inquiry into physical condition

14. General Plant Data
    (a) Foremen's meetings
    (b) Plant paper
    (c) Benefit association
    (d) Restaurant for men and office
    (e) Restroom for females

15. State Factory Law Requirements

16. General Accounts
    (a) General description of accounting methods
    (b) Scope of accounts
    (c) Statements—how often and how made
    (d) Method of inventorying
    (e) Method of pricing inventories
    (f) Machinery inventory as related to stability of production
    (g) Depreciation

17. Cost Accounts
    (a) General description of cost accounting
    (b) Job costs
    (c) Overhead costs
    (d) How controlled in general accounts
    (e) How put up for use
    (f) How used and how much
    (g) General ideas on efficacy of costs

18. STOCK-ON-HAND ACCOUNTS
    (a) General description of stock record
    (b) To what extent kept
    (c) Condition of records
    (d) How used
    (e) How effective
    (f) How controlled in general accounts

19. PAY-ROLL METHODS
    (a) General description of pay methods
    (b) Safeguards—time-clocks, etc.
    (c) Strictness as to full hours
    (d) Extent of detailed time records
    (e) How detailed time is secured
    (f) How detailed time is recorded

20. CREDIT METHODS
    (a) General description of credit department
    (b) How passed on and by whom
    (c) Insurance on bad accounts

21. PURCHASING
    (a) General description
    (b) Basis of information as to what to purchase
    (c) Policy as to quantities
    (d) Policy as to timing purchases
    (e) Attention as to excessive inventories
    (f) How prices secured
    (g) As to price versus quality
    (h) Specifications as to quality
    (i) Precautions as to whom purchased from
    (j) Receiving and checking quantity and quality

22. PRODUCTION OF GOODS
    (a) General description of producing departments
    (b) How production is ordered
    (c) Basis of orders to plant
    (d) How production is scheduled in shops
    (e) Organization of shops
    (f) Apparent efficiency of economical handling of material
    (g) Responsibility for quantity
    (h) Responsibility for quality
    (i) Responsibility for cost—who follows up

(j) Attitude of foremen as to cost records
(k) How foremen are posted regarding costs
(l) How foremen use cost records
(m) General efficiency of organization

23. Shipping
(a) General description
(b) How handled
(c) How closely checked

24. Selling
(a) General description
(b) Sales methods
(c) How organized
(d) Advertising
(e) Special points

25. General Tone of the Organization

26. General Concluding Comments

State and National Planning Activities.—The following outline from *State Planning, a Review of Activities and Progress* (Washington, D. C., 1935), published by the National Resources Board, covers the principal activities of state planning boards, as reflected in the reports in a new and important field, and serves as a useful guide for all planning studies of geographical divisions:

(9)

Outline

I. Basic Data
1. Population studies
2. Mapping
3. Climate

II. Land Planning
1. Agriculture
2. Zoning
3. Reclamation
4. Forestry
5. Indian Reservations
6. Recreation
7. Wild Life Reservations
8. Historic, Scenic, and Scientific Reserves

III. WATER

IV. POWER

V. MINERALS

VI. TRANSPORT

1. Highways
2. Railways
3. Airways
4. Pipe Lines
5. Communication Lines

VII. PUBLIC IMPROVEMENT PROGRAMS AND PUBLIC BUILDINGS

VIII. SOCIAL AND ECONOMIC TRENDS

1. Occupational and Economic Trends
2. Location of Industry
3. Unemployment
4. Relief
5. Education

IX. GOVERNMENT RELATIONSHIP

1. Federal
2. Interstate
3. State
4. Local
5. Public Finance

Market Surveys.—The following outline[11] suggests in brief compass the major facts to be discovered in a market research.

(10)

OUTLINE

I. PURPOSE, SCOPE, AND CHARACTER OF THE REPORT

II. BASIC MARKET AREAS

1. Determination of areas
   (a) Definition of areas
   (b) Square miles of each
   (c) Geographical positions
   (d) Position of city in relation to centers of population, agricultural, etc.

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[11] Prepared by George C. Smith and published in *An Outline for Market Surveys* (St. Louis, 1930), by The Industrial Club of St. Louis. The authors have omitted much detail. The 1930 *Census of Distribution* and other publications of the Bureau of the Census are valuable sources in such surveys.

2. Characteristics
   (a) Physical, including topography, climate, etc.
   (b) Economic, including population, occupations, wealth, etc.
3. Facilities for serving market areas
   (a) Commodity storage facilities; warehouses
   (b) Commodity movement facilities, including railways, water, truck, and airplane routes

III. Population Factors
1. Total population (3 classes: total, urban and rural)
   (a) Number and distribution
   (b) Color or race
   (c) Nativity
   (d) Sex
   (e) Age
   (f) Illiteracy
   (g) Dwellings and families
2. Occupation (classified by sex)
   (a) Total gainfully employed, by sex
   (b) Agricultural, forestry, animal husbandry
   (c) Extraction of minerals
   (d) Manufacturing and mechanical industries
   (e) Trade
   (f) Transportation
   (g) Public service
   (h) Professional
   (i) Domestic and personal service
   (j) Clerical

IV. Wealth Factors
1. Total wealth
2. Total wealth (annual) classified by sources
3. Per capita income: totals and income tax returns
4. Financial
   (a) Banks: deposits, savings, resources
   (b) Building and loan associations
5. Life insurance in force
6. State and city statistics
   (a) Assessed valuation
   (b) Bonded indebtedness
   (c) Ratio of bonds to valuations

V. Standard-of-Living Factors
1. Income tax returns by income brackets
2. Home tenure
3. Public utility services
   (a) Total electricity customers, classified by types
   (b) Residence telephones
   (c) Homes using gas
4. Automobiles, total and annual sales, new and used cars
5. Gasoline consumption (based on tax receipts)
6. Radios
7. Newspapers and magazines combined
   (a) 15 national magazines combined
   (b) A, B, C newspapers, by type
   (c) Farm magazines

VI. Trade Factors (in this and the succeeding section, the subheadings are full and detailed)
1. Wholesale establishments
   (a) Classifications of various sorts
   (b) Commodity net sales, by kind of business (44 classes, with 314 varieties, are listed)
2. Retail establishments (the Census of Distribution lists 200 groups)
   (a) Classifications of various sorts
   (b) Commodity net sales (food, drug, and general) (Over 200 varieties listed, with totals for each of the 3 general groups)
3. Other establishments
   (a) Meat; animals slaughtered, totals of each sort
   (b) Automobile business, all varieties
   (c) Construction industry
   (d) Hotels
   (e) Restaurants
   (f) Milk and cream sales (wholesale and retail) by milk dealers only
   (g) Service establishments (23 varieties listed)
4. Utilization of principal materials by leading industries (following the classification schedule of the Census of Manufactures, 1929, showing utilization of nearly 500 principal materials in 11 groups)
   (a) Food and food materials
   (b) Paper materials, paper and paper products

(c) Iron and steel
(d) Metals other than iron and steel
(e) Non-metallic minerals and their products
(f) Goods manufactured for assembly
(g) Paint materials and paint products
(h) Fertilizer and fertilizer products
(i) Wood and wood products
(j) Textiles, textile materials and leather
(k) Miscellaneous materials and their products (chemicals, solvents)

VII. Production Factors

1. Agriculture
   (a) Farms and farm property data
   (b) Livestock on farms; number and value
   (c) Livestock products; quantity and value
   (d) Principal crops; acreage and value
   (e) Fertilizers
2. Mineral production
   (a) Value of products
   (b) Number of employees
   (c) Principal mineral products; value and quantity
3. Fishery products including fishing areas
4. Timber products
   (a) Principal producing areas
   (b) Board feet produced annually
   (c) Kinds produced by thousands of board feet
   (d) Number of saw-mills
5. Manufacturers (following the classification of the Census of Manufactures: 16 main groups, with 331 classifications providing for 5,194 products)
   (a) Food and kindred products
   (b) Textiles and their products
   (c) Forest products
   (d) Paper and paper products
   (e) Printing, publishing, and allied industries
   (f) Chemicals and allied products
   (g) Products of petroleum and coal
   (h) Rubber products
   (i) Leather and its manufactures
   (j) Stone, clay, glass products
   (k) Iron, steel and their products, except machinery

(l) Non-ferrous metals and their products
(m) Machinery, not including transportation equipment
(n) Transportation equipment: land, water, air
(o) Railroad repair shops
(p) Miscellaneous industries

Social Surveys.—The following outline [12] will serve as an introduction to the social survey of a community. It will naturally be modified by circumstances.

(11)

OUTLINE

I. PURPOSE, CHARACTER, AND SCOPE OF REPORT
 1. Sources of information
 2. Agencies coöperating

II. HEALTH
 1. Vital statistics
 2. Health administration
 3. Food inspection
 4. Medical and hospital services
 5. Water supply
 6. Sewerage system
 7. Garbage disposal

III. HOUSING
 1. Workers' districts studied in detail
 2. Tenement houses (older types)
 3. Private residential districts
 4. Apartment houses (newer types)
 5. Lodging houses
 6. Hotels, tourist camps, etc.
 7. Congestion, play spaces, light and air conditions

IV. POPULATION STUDIES
 1. Races
 2. Nationalities, with particular reference to foreign-born
 3. Neighborhoods in which race-groups settle
 4. Housing and lodging conditions of workers
 5. Occupational statistics

[12] Based on an outline by Shelley M. Harrison published in the *Proceedings* (July, 1912) of the Academy of Political Science, Vol. II, No. 4 and reprinted by permission of the Academy of Political Science, Columbia University, New York City.

6. Economic conditions
7. Educational opportunities
8. Migration and transiency
9. Police and court statistics, legal aid
10. Social and welfare agencies for betterment, protection, and relief

V. JUVENILE DELINQUENCY
1. Case studies and analysis by districts
2. Nature of offenses
3. Individual conditions; sex, age, mental age
4. Social environment
5. Methods of handling the problem

VI. CRIME AND CRIMINALS
1. Statistics on arrests and convictions
2. Analysis of crime statistics by race, sex, offenses, etc.
3. Courts
4. Jails, houses of correction, etc.
5. Police

VII. LABOR CONDITIONS, GENERAL
1. Wages of men and women in industry
2. Hours of labor
3. Conditions of labor; laws and law enforcement
4. Organization of labor and capital
5. Individual and home conditions
6. Labor troubles, strikes, lock-outs
7. Working man's compensation, unemployment insurance, pension systems

VIII. CHILD LABOR
1. Statistics on child labor by age, sex, occupation, etc.
2. Newsboys
3. Issuance and regulation of working papers
4. Summer child laborers
5. Hours, pay, regulation among child laborers [18]

IX. STREETS AND ALLEYS
1. Refuse; extent of accumulation, removal
2. Alley and street grades
3. Drainage of surface water

[18] The following sections are modified from an outline for a sanitary survey prepared by George T. Palmer and published in the *Proceedings* (July, 1912) of the Academy of Political Science, Vol. II, No. 4. Reprinted by permission of the Academy of Political Science, Columbia University, New York City.

X. Parks
1. Public
2. Amusement
3. Bathing beaches
4. Swimming pools

XI. Restaurants, Bakeries, Food Stores, with Supply
1. Sanitation rating
2. Inspection
3. Health records of employees
4. Delivery systems

XII. City Government
1. Ordinances and laws and relation to health, welfare work, school attendance, etc.
2. Enforcement provisions
3. Coöperation of city officials

XIII. Conclusions and Recommendations
1. New ordinances
2. New policies and methods

Financial Studies.—Before an individual or an organization is willing to invest money in a business, the investor usually wishes to know about the financial structure of the enterprise, what have been the returns over a period of time, and what are the prospects for the future. The outline below contains merely the general headings for such a report, or prospectus, as it is often called. Reports of this kind are sometimes prepared by the investor and sometimes by the company, especially if it is preparing to float a bond issue or to increase its capital structure by issuing additional stock. The form is largely standardized.

(12)

Outline

I. Authorization, Purpose, Scope

II. General Information about the Industry
1. Historical statement
2. Trends, tendencies

III. The Corporation or Business
1. Name
2. History: date of incorporation, consolidations, etc.

3. Kind and volume of business, capacity
4. Other investments, ownership and control of subsidiaries
5. Location of plants and real estate
   (a) Inventory of plants, with size and capacity
   (b) Condition of plants
6. Reorganization or refinancing, with dates
7. Special agreements or contracts, patents
8. Receiverships, suits, settlements
9. Taxation and tax exemption

IV. Financial
1. Capital stock
   (a) History of capitalization
   (b) Authorized, outstanding, and par value, rate, amount
   (c) Preferred stock outstanding, preference rate, par, amount
   (d) Dividend payments—past, present, future (estimated)
   (e) Transfer agent and registrar
   (f) Subscription privileges
2. Funded debt (in order of lien on property)[14]
   (a) Amount outstanding
   (b) Kind of bond, interest, date due, interest payable when and where
   (c) Form of bond, denominations, property covered by mortgage, sinking fund requirements
   (d) Amount authorized, issued, and redeemed
   (e) First publicly offered, amount and price
   (f) Taxed covenants
3. Income accounts (tabulated by years) in detail
4. General balance sheet

V. Directory Information
1. Officers: names, with titles in order of rank and city of residence
2. Directors: names and city of residence
3. Addresses of general and branch offices

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[14] Based on an outline by Ralph U. Fitting, in *Report Writing* (New York, The Ronald Press Co., 1924), p. 64.

CHAPTER 12

EXAMINATION REPORTS—PHASES

Introductory Material.—After the examination has been completed, the expert is faced with the necessity of interpreting the results of his studies. It is the purpose of this chapter to indicate how the material which is collected in field and office should be arranged in the final draft. Although the data for an examination report may be collected by a group of investigators, the actual writing is usually done by the expert himself. As is to be expected, the report is preceded by the regular prefatory elements: title page, letter of transmittal, table of contents, and summary and conclusions. In the earlier chapters of this book these elements have been described in detail; in this chapter only the content of the report itself will be considered.

Aim.—The first phase of the text is a statement of the purpose of the examination. As indicated in Chapter 9, the ultimate aim of any investigation is not only fixed but, in most instances, is also defined by the client. It may be formulated by reference, by analysis, by a letter of instruction, or by an agreement. Although examples of all four ways have been cited in Chapter 9, typical illustrations showing how the aim is incorporated in the text are included in this chapter.

The following letter, addressed to the Board of Engineers by the International Joint Commission in connection with its examination of the St. Lawrence Waterway and incorporated in the report, is interesting because of its definiteness:

(1)

You are hereby designated to take charge of the survey of the St. Lawrence River, Montreal to Lake Ontario, for the purpose of preparing plans and estimates for its further improvement to make it navigable for deepdraft vessels of either the lake or ocean-going type and to obtain the greatest beneficial use from these waters.

The surveys, plans, and estimates are to be submitted to the International Joint Commission within 12 months and are to assist the Commission in answering the questions of a reference to the matter under the provisions of article 9 of the treaty of the 11th of January, 1909, between the United States and Great Britain. (A copy of the letter of reference is enclosed for your information.)

It is desired to expedite the completion of the duty confided to you by utilizing all available surveys and other reliable information, whether derived from public or private sources. That a proper basis of procedure may be agreed upon in the first instance, and the field work and the preparation of plans and estimates promptly and efficiently carried on thereafter, you are requested to confer fully and freely with (name of individual to be inserted), who has been designated to take charge of corresponding duties on behalf of the (name of country to be inserted), to arrange for the division of the field work and for coöperation in the preparation of the desired plans and estimates. While it is clear that the field work necessary to complete existing information may properly and advantageously be divided, coöperation and unity in the preparation of plans and estimates seem preferable.

It will be noted that the reference to the Joint Commission contemplates four different general schemes or methods of improvement, as follows:

(a) By means of locks and navigation dams in the river
(b) By means of locks and side canals
(c) By a combination of the two preceding methods
(d) By means of locks and power dams

The plans and estimates should definitely cover these four general schemes or methods of improvement, but other variations of them may be considered and, if deemed advisable, also presented to the Commission.

The channels to be considered are to be of 25 and 30 feet depth at low water, and the plans and estimates should be prepared correspondingly. A choice between them will, under the terms of the reference, be made by the Commission.

As detailed plans cannot be prepared within the time limit of one year fixed for this work, it is desired that merely outline plans and lump-sum estimates based upon experience from similar work —such as the enlargement of the Welland Canal and power development at Niagara Falls—should be submitted.

The general schemes should be furnished to the Commission, showing, first, the best for navigation alone, and, second, for the most efficient utilization of the waters of the St. Lawrence for navigation and power, together with the approximate costs thereof.

As the handling and disposal of ice is a fundamental difficulty on the St. Lawrence River, the arrangements regarded as being necessary for this purpose should be discussed as well as those recommended for ice disposal during the construction period and thereafter.

Regulation of the levels of Lake Ontario so as to equalize the discharge of the St. Lawrence may be desirable in the interest of navigation, of ice disposal, and of power development. If the plans include any provision for such regulation, an explanation should be furnished to make clear just what is proposed.

Finally, you are requested to keep the International Joint Commission fully advised of your progress and to maintain close and sympathetic touch with it so as to insure complete coördination.

As indicated by the letter of the Commission, the data secured through the investigation led to a recommendation report. This fact, however, did not alter the character of the instructions, which included explicit references to the aim and scope of the study. The minuteness of some of these suggestions is a unique feature which is seldom duplicated unless there is a formal contract between expert and client.

Often the writer may find it simpler to restate the aim and scope of the report in his own language instead of introducing into the body of his text a long quotation from his authorization. Thus Mr. C. L. Hill, co-editor of the *Final Report on Marine Borers and Their Relation to Marine Construction on the Pacific Coast* (San Francisco, 1927), interpreted the aims of the report as follows:

(2)

Objects and Organization of the Work

The objects of the survey were to determine the extent of the damage from marine borers in San Francisco Bay, especially that of epidemic severity which had occurred within the preceding three years in the northern portion of the bay; to determine the present distribution of the several marine borers and as much of their past

history in the bay as it was possible to learn; to increase the present knowledge of the dissemination, growth, and habits of the borers; to study factors influencing the rate of attack and amount of damage from them, including the effects of climate and river discharge upon the salinity conditions of the bay; to throw more light upon the effectiveness, both in physical life and economic advantages, of the various methods of protecting wooden piling, and of the substitutes for it, together with the best methods of construction which had been developed; and to collect data on the relative costs of the different methods of protection and construction.

Where, as in the revised *Agreement in Respect to the Proposed Observation and Tests upon the Operation of Heat, Light, and Power Services from the Plant in the Hall of Records Building, Borough of Manhattan,* all the details have been threshed out in conference between the parties to the contract, the terms of association may be set forth by a hard-and-fast outline. In the "Agreement" mentioned above, there are thirteen sections. The first of these runs as follows:

(3)

The several parties hereinafter named mutually agree upon the conditions:

1. The object of the observation is the determination of data by means of which a year's cost of electrical and steam services, with respective operating and fixed charges as conducted under the direction of the President of the Borough of Manhattan, may be arrived at. It is proposed to compare this result with:

a. The annual cost obtaining during the year 1911.

b. The operation of the same services by the utilization of the electrical service of the New York Edison Company, with or without the steam supply of the New York Steam Company, with accompanying reduction of labor and other expenditures and standing charges.

The determination of the various items in the accounts making up the total cost of the supply of electricity and steam heat shall be agreed upon by the engineers and accountants, and the accountants shall be advised by the engineers as to the various items which shall be chargeable to the different accounts. The accountants referred to are those designated in accordance with clause 7.

Here not only the object of the examination but also the way in which the significance of the result is to be determined are included in the articles binding those interested in the study.

Scope.—Ordinarily, then, since the aim is set forth in a document which can be, and often is, incorporated in the report, the indication of the scope is the first phase of the text in which the writer is thrown largely upon his own resources. As pointed out in Chapter 9, there are occasionally limitations regarding territory, technique, time, or expense that are fixed by the client. More often the expert is given right of way. He can set the boundaries for himself. As described in this section of the report, however, the limits are not those which he sets but those which he reaches. In practice, the two seldom correspond.

In the course of their studies, as reflected in the following paragraph from their *Report,* The Chicago Traction and Subway Commission on a Unified System of Surface, Elevated, and Subway Lines found it advisable not only to consider conditions in Chicago at the time when their investigation was made but also to anticipate those likely to exist in the future:

(4)

The ordinance outlining the scope of the Report contemplates not merely improvements that are needed today but the laying of the foundation for a system of transportation that can be developed and extended as the needs of Chicago may dictate. The greatest difficulty in developing a plan for a transportation system is that it can never be completed but is always growing; in fact, the traffic increases at a faster rate than the population of the city itself. The consumption of food, water, or light, for instance, increases substantially as the city grows; that is, if the number of people be doubled, twice as much food, water, or light is used, with some additional allowance for increased per capita consumption due to increased wealth. But in the case of transportation, if the city's population is doubled, there are not only twice as many people to carry, but, in general terms, they must be carried farther; the rides per capita are largely increased, and to cover the increased distance in reasonable time, a faster speed is necessary. A plan that will answer the demands of service must, therefore, keep in view not only

the present and the immediate future but, so far as possible, the requirements of following years as Chicago keeps on expanding. It must be based on a definite and sound theory and at the same time be so elastic as to meet the varying conditions that will arise from time to time.

Similarly, in the *Report from the Chief Engineer on the Tennessee River and Tributaries . . . covering Navigation, Flood Control, Power Development, and Irrigation* (Washington, D. C., 1930), are sections listing the streams surveyed and explaining allocation of the $910,075.51 funds spent on the survey. These sections are followed by one entitled, "Data Collected by the Survey," which is reproduced below:

(5)

Data collected by the survey include:

Maps and profiles for the main stream and major tributaries.

The layout of projects, including alternate projects, for the development of the main stream and major tributaries.

Stream gaging for a number of stations on the main stream and tributaries in coöperation with the United States Geological Survey.

Studies of the effect which the projects would have upon regulation of stream flow, power and flood control and benefits resulting therefrom.

Investigation of dam sites, including cross-section sketch.

Investigation by geologists, wash borings, and core borings of a few holes at the most important sites on the main stream and Clinch and Powell Rivers.

Detail core boring and investigation of Cove Creek dam site.

Commercial statistics, including the commerce which may be developed for navigation, and the market which may be developed for power, and a mineral survey of the basin.

Engineering data on each project and the general layout and estimates of cost for each project.

Benefits resulting for navigation and the economic feasibility of navigation, water-power and flood control projects.

General plans for the development of the river and its major tributaries for navigation and the prosecution of such improvement in combination with the most efficient development of the potential water power, control of floods and the needs of irrigation.

Also special data called for by the Act of Congress approved May 15, 1928.

While the foregoing data are sufficient to permit the formulating of general plans for the development of the river in which the sites to be investigated are located, the detail investigation of dam sites, with the exception of Cove Creek, and estimates of cost based thereon are not sufficiently definite to permit the exact determination and detail layout of the various projects. . . . The cost of detail core borings similar to those made for Cove Creek is very great and expenditures for that purpose do not seem justified until detail plans for the actual improvement are decided upon.

This statement of scope is both clear and comprehensive. Although limited by the funds available, the factor of unjustified expenditures was also considered. As every adequate statement of the kind should do, this one indicates the boundaries reached by the examiner and not those which he set before him when he began his duties.

Procedure and Organization.—It is often advisable to include in the introductory section of the report facts of interest about the plan of the report, the personnel of the staff, the procedure followed in securing data, and similar matters which are of historical value. Thus, in the *National Power Survey Interim Report,* Power Series No. 1 (Washington, D. C., 1935), the author explains the formation of the staff and introduces the personnel, after which he describes the procedure followed in preparing the report. The following excerpt will indicate how this material was finally presented:

(6)

Because of the magnitude and extent of the Survey, it was apparent that much of the information required regarding present utility developments and the power market must be obtained from the various electric utilities through visits to the larger systems; also, that much of the data regarding power resources would of necessity be obtained from the various Federal and State agencies. With this in mind preliminary conferences were held with the other Federal agencies . . . to determine the extent and source of data and to arrange for obtaining all information available and the cooperation of all Federal Agencies.

The Commission also invited a number of the leading representatives of both public and privately owned utilities to participate in the preliminary conferences on ways and means of making this survey. The first of these conferences was held on April 18 and 19, 1934. . . . The second preliminary conference took place on April 25 and 26, 1934. . . .

The scope of both the power survey and the concurrent related survey of electric rates was outlined and discussed and the tentative outline of questionnaires submitted and considered. Valuable suggestions were obtained from the various municipal and private utility representatives and those present gave assurance of the wholehearted coöperation of the various interests in supplying data, thus making possible as adequate a survey as could be made within the limitation of funds and time available.

Following the conferences, an exhaustive report form dealing with the power phases of the electric utilities was prepared. . . . These report forms were mailed to all private and municipal electric utilities in August and September, 1934. Prior to the mailing of the report blanks, the engineers of the National Power Survey called on all of the major private and municipal utilities to explain the forms to be used. . . . Upon the mailing of the report forms the field staff agents . . . followed up inquiries made of private and municipal electric utilities, advising and assisting them in preparing the returns.

Office Work.—The results of the office work as they appear in the report include references to

1. Records and documents
2. Data and statistics
3. Analyses and conclusions

As a rule, they are reproduced literally.

For instance, in the *Report of the Transit Commissioner, City of Philadelphia,* is the following passage:

(7)

LEGISLATION

At the beginning of the transit inquiry it was found that the City of Philadelphia was devoid of legal authority to construct or own transit facilities and also that the City lacked the necessary financial resources under the then existing legislation. Consequently,

the legislation necessary to enable the City to establish and, where advisable, to finance and construct satisfactory transit facilities was outlined after careful consideration and submitted to, and passed upon, by eminent counsel appointed by the Mayor, who then drafted the necessary bills for presentation to the Legislature. All of them have been enacted and signed by the Governor.

A brief outline of these acts follows. . . .

Here, an essential part of the office work was a study of legislative enactments affecting the right of the City of Philadelphia to construct, or to own, facilities for the transportation of its citizens. Similarly, in investigating a hydroelectric project in one of the Western States, a consulting engineer found it necessary to secure the advice of a firm of lawyers, whose opinion is incorporated in the text of his report.

Frequently the history of an enterprise or an account of previous work done on the same project may properly be included in an early section of a report. Such an account will necessarily be based on office study. An interesting combination of history and analysis of previous work is to be found in the *Report of the New York State Commission on Ventilation* (New York, 1923). More distinctly of a historical nature is the first section of the *Report of the Special International Niagara Board* (Washington, D. C., 1931), which devotes a section to "Earlier Investigations into the Preservation of Niagara Falls."

(8)

In its consideration of the Niagara problem the Board has reviewed the earlier investigations which have been made into the conditions obtaining at the Falls, and which have had a bearing on their recession and their preservation. Among the more important of these earlier investigations might be mentioned the following: [18 are listed and discussed briefly].

The *Report* then proceeds to review in some detail the history of the movement to preserve the beauty of the Falls, with significant comments on the various achievements.

Of a different sort but equally valuable is the purely historical material often presented in the early section of a report.

For instance, although it is a final rather than an examination report, the *Final Report on the Bridge over the Delaware River Connecting Philadelphia, Pennsylvania, and Camden, New Jersey* (Philadelphia, 1927) begins with a "Historical and General Narrative," which recounts the projects for bridging the river from the earliest one in 1818 to the final opening of the present bridge in 1926. Again, in the market survey published by the *Literary Digest, Zanesville and 36 Other American Communities* (New York, 1927), the chapter entitled "How America Came to be America" traces briefly the history of Zanesville as a necessary background for understanding the findings of the survey. Historical summaries like these help the reader to visualize the conditions studied and throw into relief the facts established by the investigation.

Occasionally the history of an enterprise, whether it be a government agency such as the United States Housing Corporation or a private organization like the United States Steel Corporation, may properly be included in the section of an examination report which deals with the work done in the office. Such a review occurs in the *Report* dealing with the affairs of the first of these two undertakings.

(9)

On March 1, 1918, Congress authorized the United States Shipping Board to spend $50,000,000 from its general appropriation to provide houses for ship workers as a necessary part of the expense of building ships. At first the Shipping Board made use of Mr. Eidlitz's personnel in an advisory capacity; later the Shipping Board established a housing organization of its own. In the meantime Mr. Eidlitz and his collaborators, receiving money for essential expenses from the President's emergency fund and also from the Navy, had determined on a tentative scheme of procedure, had investigated some of the most pressing housing-shortage situations, and had prepared as far as possible to facilitate the work of whoever should be finally designated to deal with the Government's housing problem.

On June 18 the President delegated to the Secretary of Labor the authority given him by Congress on May 16 to expend $60,000,000 (appropriated June 4, raised to $100,000,000 July 8) "for the purpose of providing housing, local transportation, and

other general community utilities for such industrial workers as are engaged in arsenals and navy yards of the United States and industries connected with, and essential to, the national defense, and their families only during the continuation of the existing war."

By executive order, confirmed in the Act of June 4, 1918, the Bureau of Industrial Housing and Transportation was created in the Department of Labor, and Mr. Eidlitz was appointed Director.

On July 25, 1918, the United States Housing Corporation, created as an executive agent of the Housing Bureau, was first authorized to expend these funds for actual acquirement of land and for construction.

A summary like this will help a reader to visualize conditions in a bureau or a factory and will throw into relief the facts established by the investigation. In the study of an industrial organism, it is indispensable.

Procedure in the Preliminary Examination.—After the results of the office work have been reviewed, the next topic to be considered is the preliminary examination. As a rule, it is well to explain briefly, in a single paragraph, the plan of campaign adopted. Just as a reconnaissance assists an examiner in his final survey, so an explanation of this kind helps a client to understand the rest of the text.

An admirable example is the exposition of the technique developed by the United States Housing Corporation in reconnoitering the communities containing plants certified by the War Department or the Navy Department as being unable to care for their employees:

(10)

First Investigation

We sent an investigator to the town to bring back answers to the following three questions: (1) How great a labor shortage did there appear to be? This was a check on the reports from the industries themselves. (2) How far was this shortage due to lack of housing facilities and how far to other troubles such as bad working conditions and lack of amusements? If the trouble was not in the scarcity, or inaccessibility, of houses, it was not our business to help it. (3) If the labor shortage, present or expected, was due to some kind of insufficiency in housing, could it be helped by

putting more of the existing rooms and houses into the market, by providing transportation to houses now hard to reach, or by building new houses? And, roughly, what provisions of any or all of these kinds would meet the case? The investigator spent several days on the spot. He got from the manufacturers concerned, who were having trouble in maintaining labor supply, information as to the kind of workers employed, the wage scales and labor turnover in the different classes of workers, and other information as to the conditions at the manufacturing plants. He consulted with the labor leaders. He got in touch with the civic organizations to get some idea of what, and how many, people already needed help. He made visits to the dwellings of employees, and talked with the men and their wives, to see how they were living and how contented or discontented they were with their conditions.

In this instance, the preliminary examination consisted largely of interviews. Through these interviews, the investigator secured for the Chief the facts required to enable the latter to decide whether aid was justifiable or not.

Tentative Result.—A summary of the tentative result, which, under the circumstances described above, is subject to revision, forms a logical introduction to the final study. The nature of this section has been suggested by the two extracts in Chapter 10. It will be interesting, however, to notice its character in the case of the report which has just been mentioned. As always, the summary is relatively short.

Interdepartmental Committee

The investigator read his report to the Chief and the division heads of the Corporation, meeting with representatives of the War and Navy Departments; and after full discussion, if the need proved to be sufficiently great in relation to other war needs, an allotment of money was made to be spent in relieving the trouble as far as possible. Before allotting money for the construction of new houses, however, the Joint Committee considered whether the situation could not be met, wholly or in part, by any of the less expensive expedients such as placing the war contracts elsewhere, encouraging private enterprise in home building, throwing open all present housing, and making more housing accessible by transportation. Only the difficulties which could not be overcome in any of these ways were met by new house construction. Since the

total funds of the Corporation were not a fifth part of what it would have cost to build all the war-workers' houses which seemed to be really needed in the country, we could in any one place only take off the worst of the burden. Under these circumstances, we were usually able to make some estimate of what would probably be the labor and housing conditions in each place after the war and to plan to build no more permanent houses than would be still useful, and therefore valuable, at that time.

As pointed out in the next paragraph, the purpose of the preliminary examination was to determine "in a general way what, and how big, the problem was." It would be difficult to think of a more accurate definition.

Procedure in the Final Examination.—After the problem has been defined—that is, after the result of the preliminary examination has been made clear—an explanation of the procedure followed in the final examination is in order. That to be found in the report which has just been used for illustration supplements the two extracts quoted in the preceding paragraphs:

SECOND INVESTIGATION

It being thus determined in a general way what, and how big, the problem was, a real estate scout was usually sent to the town to prepare a preliminary report on the real-estate situation in the town and on the probable value of the tracts of land most available for our development. Immediately after receipt of his report—indeed often meeting and collaborating with him on the ground—a "second investigation team" was sent out, composed usually of one man each from the Architectural, Engineering, Town Planning, and Real Estate Divisions of the Corporation. A man from the Transportation Division was sometimes added to these, or sometimes went alone, according to the case. At the same time, if not before, the Homes Registration Division started its campaign to list all vacancies at a central office and to open to the workers all vacant houses and rooms previously held out of the market.

Arrived at the town, each member of the "second investigation team" took up his own work. The architect found out what he could as to the kind of houses most practicable to build and the kind that the workers would like. He talked to the workers, and especially with their wives, and got some idea of how, and where,

they wanted to live; he talked to the employers and got a statement of the wages paid, from which rent to be expected could be reckoned; he talked to citizens generally and kept his eyes open as he went about with the rest of the team. He also investigated local supplies of building material, labor conditions in building trades, and similar construction problems. The transportation man learned about the street-car lines and the railroads, what housing areas they made available and how efficient was their service. The realtor found ready for him, or soon obtained, the appraisals of property by the real estate scout, and later there were available detailed appraisals of the required land, prepared, at the request of the Real Estate Division of the Corporation, by the mayor, the local real estate board, the Rotary Club, and the assessor in coöperation. Using this information, the realtor advised as to the practicability of each site for building-investment purposes. The engineer studied the water supply and other utilities of the city and its different sections, considering what new construction was needed on each site and what arrangements, if any, would be necessary with the municipal authorities as to construction and upkeep to incorporate the additional utilities into the municipal system. The town planner weighed relative advantages of different neighborhoods, such as accessibility, ease and economy of subdivision, attractiveness, and suitability of topography and soil. The Committee as a whole studied each proposed housing site and made notes of its total relative advantages of cheapness, accessibility, ease of development, and appropriate types of houses. Often the Committee met again in the evening and discussed their results for half the night. After two or more days of this concentrated work, depending on the size and complication of the district, they were usually ready to report their recommendations as to what kind of houses should be built, what site or sites should be chosen for the houses, and what transportation, if any, to the factories or to the town should be provided from these houses or from any others to be made available.*

The report of this investigation was perhaps the most important move which was made on each project. The Corporation chiefs at Washington reviewed the report, of course, but they would seldom reverse the decision of those who had actually studied the job at first hand. The choice of site, entailing subsequent negotiations for purchase, or perhaps requisition proceedings, required on the

* For a more complete idea of the technical details of these investigations, see Instructions (Appendix, p. 437).

part of the realtor a keen sense of what makes real estate values. The possibility of developing the site had to be determined before any choice could be made; and this meant that the engineer and the town planner had to work out enough of a tentative scheme of development to be sure that the site could be quickly and economically drained, sewered, provided with water, graded, and made accessible by streets. It speaks well for the men who did this work under so much pressure that very seldom has the Corporation afterwards repented of the decision of its investigating team.

Permanent Result.—In a report, the details suggested by the exposition in the last paragraph must be arranged in definite order. There will be a section devoted to facts secured by observation; one to facts obtained by sampling; one to facts secured by interview, and one to facts obtained by the questionnaire. The organization and presentation of these data must therefore be considered.

Information Secured Through Observation.—Observation is always one of the chief sources of information. The expert may find it necessary to examine the topography of a district and to describe its distinguishing characteristics. As in *A Report . . . Containing a General Plan for the Improvement of the Potomac River,* by the United States Army Engineering Office (Washington, D. C., 1934), a description of this kind is often carried on by reference to the points of the compass:

(11)

I. General Description of Watershed

1. Location of Stream.—The Potomac River has its beginning in the Appalachian Range of eastern West Virginia and western Maryland and crosses the Atlantic slope in a general southeasterly direction to Chesapeake Bay. In its meandering course of 383 miles it forms the southern boundary of Maryland from which it separates the States of Virginia and West Virginia. . . .

2. Stream Characteristics.—The main trunk of the Potomac River is formed by the junction of the north and south branches, 21 miles below Cumberland, Md. The North Branch, which is the actual head of the river, rises near the western corner of Maryland, flows in a northeasterly, then southeasterly direction for 96 miles to its junction with the South Branch. From this point the main stream assumes a general southeasterly direction, widening

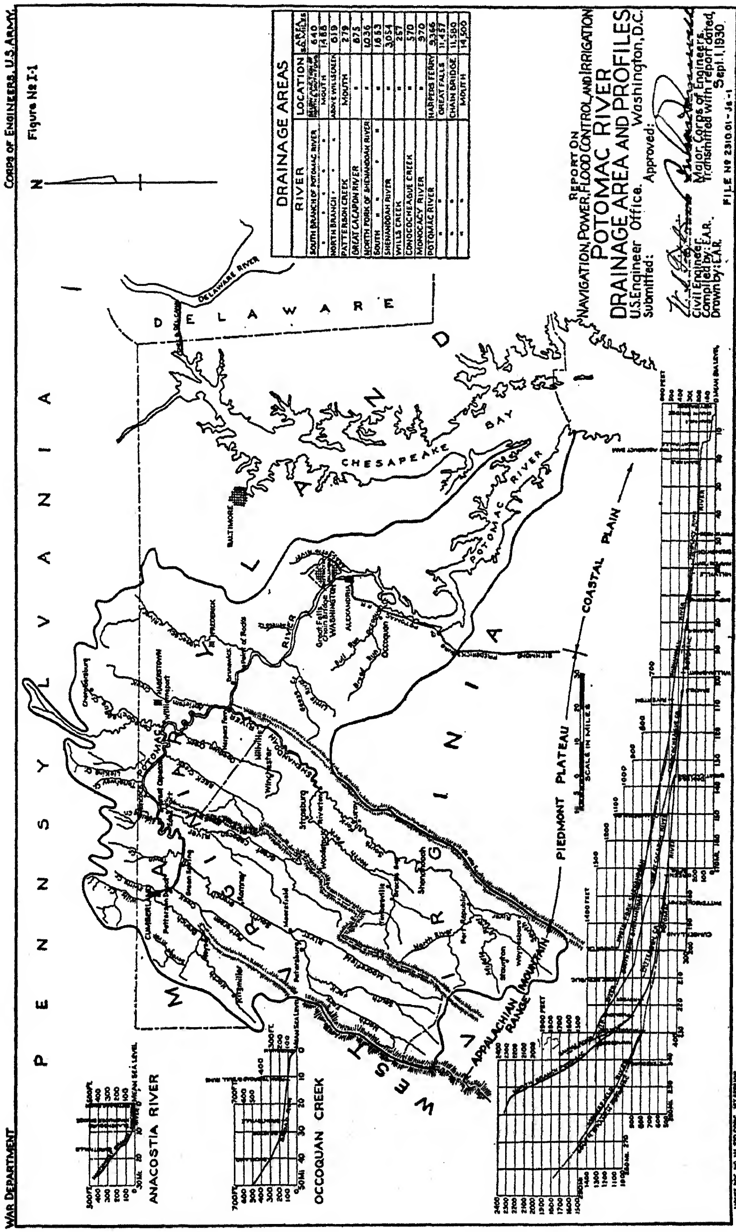
gradually as it receives the flow of its principal tributaries, until it reaches tidewater at Washington, 170 miles downstream. Here its characteristics change and the stream continues as a rather broad and deep estuary for 117 miles to its mouth in Chesapeake Bay. . . .

6. Physical Features.—The Potomac Basin stretching from the Alleghanies to Chesapeake Bay lies within the three more or less sharply defined regions known as the Coastal Plain, the Piedmont Plateau, and the Appalachian Region. These three districts follow the Atlantic coast of the United States in varying widths from New England southward to the Gulf.

7. The Coastal Plain includes that portion of the drainage basin lying east of the ancient shore line commonly called the "Fall Line," which is roughly marked by a line drawn through Richmond, Fredericksburg, and Washington. A somewhat arbitrary extension of this line is furnished by the Baltimore & Ohio Railroad to Baltimore and Wilmington. The topography is rolling, being built up of a system of terraces of varying elevation from sea level to 250 feet. The surface slopes gently eastward toward Chesapeake Bay, declining at an average rate of about 3 feet to the mile.

8. The Piedmont Plateau is the name applied to the hill country that borders the Coastal Plain on the west and extends thence to the foot of the Appalachian Mountains. A line drawn across the basin in a slightly northeast direction, passing a few miles east of Harpers Ferry, would roughly mark the western boundary. This region of the basin is rolling in character. Its surface is traversed by highlands and cut by valleys that at times trench the uplands as deep gorges. The variation in altitude is from 100 to 1,000 feet, averaging near the western border between 500 to 600 feet.

9. The Appalachian region borders the plateau region on the west and extends beyond the western limits of the basin. It consists of a series of parallel mountain ranges with deep valleys which are cut nearly at right angles throughout much of the distance by the Potomac River. In Maryland many of the ranges exceed 2,000 feet in elevation, and some reach nearly 3,000 feet in the western portion of the basin near the divide. In Virginia and West Virginia the ranges attain elevations of 2,000 to 4,500 feet, and it is between these elevations that many of the smaller streams have their sources, descending rapidly until they join the larger tributaries on their way to unite with the waters of the main stream. The streams of this region have been to a large extent adjusted to the rocks over which they flow, although this is less evident in the case of the Potomac than of the tributaries.


WAR DEPARTMENT
CORPS OF ENGINEERS, U.S. ARMY.
Figure No I-1
DRAINAGE AREAS
RIVER | LOCATION | AREA SQ. MILES
SOUTH BRANCH OF POTOMAC RIVER | | 640
" " " " | MOUTH | 1,488
NORTH BRANCH " " | ABOVE WILLS CREEK | 619
PATTERSON CREEK | MOUTH | 279
GREAT CACAPON RIVER | " | 675
NORTH FORK OF SHENANDOAH RIVER | " | 1,036
SOUTH " " " | " | 1,653
SHENANDOAH RIVER | " | 3,054
WILLS CREEK | " | 257
CONOCOCHEAGUE CREEK | " | 570
MONOCACY RIVER | " | 970
POTOMAC RIVER | HARPERS FERRY | 9,366
" " | GREAT FALLS | 11,457
" " | CHAIN BRIDGE | 11,580
" " | MOUTH | 14,500
REPORT ON
NAVIGATION, POWER, FLOOD CONTROL AND IRRIGATION
POTOMAC RIVER
DRAINAGE AREA AND PROFILES
U.S. Engineer Office. Washington, D.C.
Submitted:
Approved:
Civil Engineer.
Compiled by: E.A.R.
Drawn by: E.A.R.
Major, Corps of Engineers.
Transmitted with report dated, Sept. 1, 1930.
FILE No 2310.01-J4-1
PENNSYLVANIA
DELAWARE
MARYLAND
WEST VIRGINIA
VIRGINIA
DELAWARE RIVER
CHESAPEAKE BAY
POTOMAC RIVER
BALTIMORE
WASHINGTON
ALEXANDRIA
PIEDMONT PLATEAU
COASTAL PLAIN
APPALACHIAN RANGE
SCALE IN MILES
ANACOSTIA RIVER
OCCOQUAN CREEK

In a passage like this, there is no physical point of view. On the other hand, many topographical descriptions are dependent upon the retention of a definite vantage ground. If a writer chooses to portray a scene in this way, he must be careful not to shift his position unless he desires to produce a panoramic effect. Whatever the method employed, a "fundamental image," which is really an extended metaphor, is likely to be of aid. By this method, a stretch of territory is compared indirectly with an object familiar to the client. Thoreau, picturing Cape Cod, speaks of it as the "bared and bended arm of Massachusetts" buffeting the storms of the Atlantic, and Wordsworth, representing himself as perched on the top of Scawfell, portrays the Lake District in terms of a wheel with one of the spokes broken in two. Since the aim of any topographical description is to give a general idea of the more important elements in a landscape, this device has much to commend it.

Descriptions of interiors are even more important than descriptions of exteriors. As in the following paragraphs from Chapter XVII, "Plan and Scope of the Field Investigations," *Report of the New York State Commission on Ventilation* [1] (New York, 1923), they are often developed like the previous extract:

(12)

Description of the Experimental Plant of the Commission at School 51

The rooms in question were known as Rooms 203 and 205. They were situated on the second floor of the building, having but one outside exposure, facing the northwest at about fifteen degrees from true west. Each room contained 48 pupils' seats and a teacher's desk. . . . The rooms were heated as is customary in the school buildings of New York City with direct radiators of sufficient surface to heat the rooms independently of the ventilating plant, the heating equipment consisting of three-column cast-iron radiators, 39 inches high, each room having two of these radiators of 90 and 85 square feet surface respectively.

[1] Reprinted by permission of E. P. Dutton & Co., Inc., publishers.

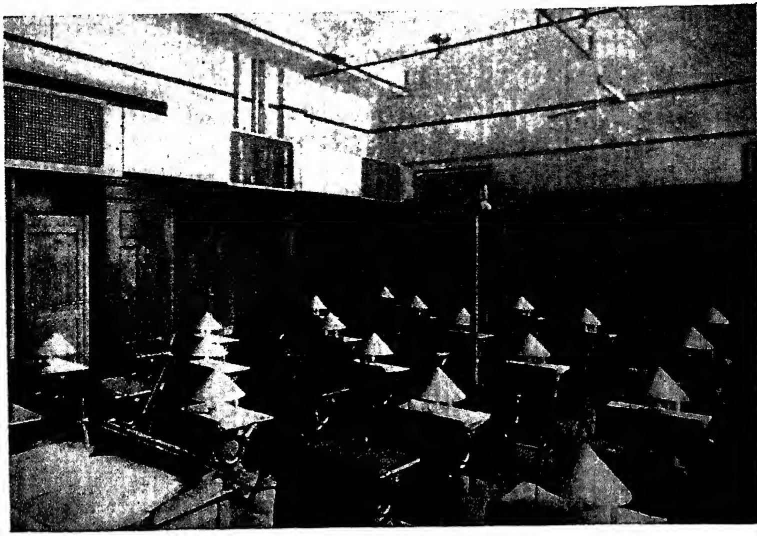


Figure 1. View of Rear Wall of Room 203, Showing Registers

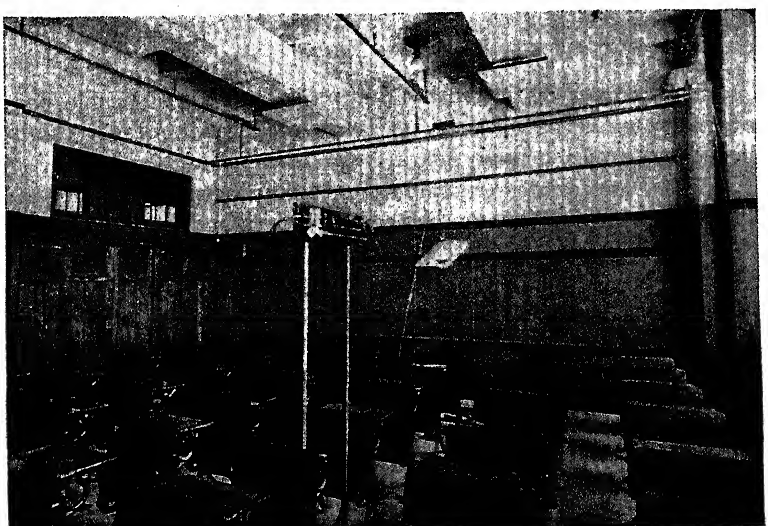


Figure 2. View of Rear of Room 205, Showing Ceiling Ducts and Outlets as Completed. Recording Instruments on Supports in Foreground.

(From *Report of the New York State Commission on Ventilation*, pp. 226 and 227)

Many descriptions of this character are little more than catalogs of the units in the various rooms of a plant. These catalogs, however, invariably contain references to the arrangement and function of the mechanisms or machines described. Where, as often happens, rooms are devoted to different steps in the process of manufacture, a moving point of view, which will produce a narrative effect, is sometimes advantageous. All literal descriptions are usually supplemented by diagrams or photographs.

Exercise: Description.—Describe one of the interiors and one of the exteriors mentioned below. Wherever advisable, introduce diagrams and photographs.

Exteriors: a boulevard; a campus; a canal; a city park; a dam; a drill ground; a farm; a garden; a harbor; a military camp; a municipal playground; a waterfront; a peninsula; a small island; a stadium and athletic field. Interiors: an amphitheatre; an armory; a baggage room; a barracks; a car barn; a chemical laboratory; a commercial garage; a creamery; an electrical laboratory; an ice-cream plant; a laundry; a mechanical laboratory; an office; an operating room; a post-office; a power plant; a room for physical examination; a slaughter house; a switchboard room; a theatre; a waiting room in a railroad station; a work shop.

Information Obtained by Sampling.—A considerable part of many examination reports is devoted to the facts established by sampling materials in bulk or in series.

Where materials, either raw or manufactured, have been sampled in bulk, the method of selection and reduction and the character and result of the analysis must be described in detail. The exposition of the technique used in examining coal, as explained in Chapter 10, is an excellent example of the form which should be employed. The description of the laboratory procedure and the exposition of the reaction obtained correspond closely with the phases of the experimental report, which is discussed at length in Chapters 17-20. Conclusions may be summarized by any of the devices—tabular, graphic, literal—illustrated in Chapter 7.

Where a series in time or space, in which efficiency is the desideratum, is sampled, tests are imperative. Under these circumstances, the descriptions will contain notes on materials,

apparatus, methods, and results. Since the treatment of materials and apparatus is explained fully in Chapter 19, in connection with the experimental report, only the exposition of methods and results need be considered in this chapter.

A characteristic passage is to be found in J. B. Huntley's report, "Impact in Steel Railway Bridges of Simple Span," *Proceedings* of the American Railway Engineering Association for 1936. In the passage quoted below, Mr. Huntley is careful to indicate that his tests were made under actual service conditions.

(13)

The particular period during which this work was undertaken was a most inopportune time to ask for special test engines and cars, so that, with a few exceptions, all readings were taken during the passage of some regularly scheduled train. With the present comparatively light traffic, not many tests could be had in any one day, and with the several classes of locomotives in service but few tests could be had of any one class, and such runs, normally, were likely to cover a very narrow range of speed. This required staying at each bridge until what seemed to be sufficient data had been collected. Even then it might be found, when the records were later worked over in the office, that runs, at the very speed most needed, had not been encountered. This meant going back for additional tests, whenever it could be arranged.

On the other hand, the use of these regular trains had its advantage, as the tests more nearly represent actual service conditions. With special test equipment it is unlikely, even in the most prosperous times, that more than three or four locomotives from the different classes would have been assigned for the work. Taking the trains as they came, use was had of about 300 engines, of 43 classes, in various states of repair. The records were taken during the passage of the entire train, which gave much information as to the effect of practically all types of cars, under various conditions of loading; something which we would not have had with special trains. The ideal arrangement, no doubt, would be to use both regular and special equipment.

In a few instances, when it was particularly important and not too inconvenient, an engine, or an engine and a few cars of known weight, would be borrowed from a work train or local, to make several runs over a wide range of speeds. This saved a great deal

of time, and often made possible a comparison of a series of tests with one locomotive, with tests from several locomotives of that same class.

There was a considerable difference in speed between passenger and freight trains, and usually some difference between eastward and westward movements. If, with these natural variations, a satisfactory range was not obtained, it was frequently possible to arrange for a few trains to run either faster or slower, than was customary, to give a few needed speeds. Even though but few tests might be obtained on one class of locomotive, it was possible, where several classes were enough alike to produce about the same static deflection or span frequency, to combine them, after reducing the various amounts of overbalance, in their counterweights, to some common denominator.

These regular trains carried a variable engine tender load, particularly between the movements in opposite direction, and the cars, especially in freight trains, were of many types, carrying any load up to capacity. On spans of more than 60 ft. in length, it was necessary to take this into account. From the coal and water records and known fuel consumption characteristics of the various types of locomotives, it was possible to arrive at a close approximation of the tender loading at the time of the test. The initial, number, and gross weight of each of the first few cars were obtained from the train reports. At times it was possible to have a run at slow speed, and with cars of known weight, or to measure the deflection under some known quiescent load. With such information, the true deflection factor of the span could be determined, from which the deflection under any other loading could be calculated. [2]

As suggested by this extract, a mere outline of the steps in the procedure is not sufficient. In addition, the writer ought to make clear to the reader that the necessary tests have been conducted under conditions which are likely to produce accurate results. Due allowance must be made for extraneous influences that are likely to affect the experimental data. Facts of this kind are properly included in the report.

A typical exposition of a series of tests on "The Effect of Saturation Temperature and Fuel Bed Depth on Producer Gas," conducted by Charles R. Locke at Chicago, occurs (pp.

[2] Reprinted by permission of the American Railway Engineering Association.

961 ff) in the "Report of the Subcommittee on Producer Gas," *Proceedings* of the American Gas Association for 1929. In his report Mr. Locke not only has taken unusual pains to state his facts definitely and clearly but also has indicated explicitly the manner in which he has controlled the factors to eliminate all the variables except that which he was studying—saturation temperature:

(14)

A series of tests was run to determine what effect changes in the temperature of the air and steam mixture and fuel bed depth would have on the gas produced in a standard coke fired producer. The producer used in the tests was a standard center-feed Koppers Kerpeley Type and was one of a battery of ten in the plant of the Chicago By-Product Coke Company.

This producer was 10 ft. in diameter, 10 ft. 1 in. in height from bottom of the water jacket to the center of the gas outlet, and has a grate opening equivalent to 255 sq. in., which was made up of 766 ⅝-in. holes and 103 ½-in. holes. The steam raising equipment consisted of a water jacket 12 ft. 4 in. outside diameter, 10 ft. inside diameter, and 5 ft. 8 in. in height, together with a Western Gas Fire Tube Waste Heat Boiler of 85 rated h.p. These boilers ordinarily make an excess of steam over that which is required for gas making and pumping purposes. Steam at approximately 10 lbs. pressure was generated in the water jacket while the waste heat boiler produced steam at 200 lbs. pressure. This particular producer with its boiler had been given a complete overhauling a short time before the tests and was in excellent mechanical condition.

INSTRUMENTS AND SAMPLING

The saturation temperature was recorded by a standard Foxboro thermometer of a range of 0° to 120° C. This instrument was comparatively new and was checked frequently throughout the test period. The flow of air to the producer was measured by a Republic flow meter equipped with indicating, recording, and integrating devices.

Gas samples were taken by drawing off a definite quantity of gas each hour from the outlet of the producer into a calibrated bottle which at the beginning of the test had been filled with water that had been completely saturated with gas. This method of gas

sampling was decided upon after several failures with continuous samplers all of which were caused by dust stoppages. Gas analyses and calorific values were determined by a Morehead apparatus which on previous tests had checked the B.t.u. as determined on large quantities of gas in a Thomas calorimeter to within 1.5 B.t.u.

Samples of ash from the producer were obtained by quartering down one-half of the total ash made during the test period. This method gave, we believe, a representative sample.

All fuel to the machine was weighed in cars and samples were taken by hand from the belts for analysis and screen tests.

Fuel Used

The fuel used for these tests was small nut coke, commonly known as No. 2 Nut or Pea, size which averaged 1" x ½". The average screen test showed 89% over ½ in. and 11% under with a maximum plus variation in the coke over 1 in. of 5% above the average, and a maximum minus variation of 6% below the average in coke under ½ in. The coke was clean and contained only a small percentage of material through a ⅛-in. screen. The average analysis of this fuel was:

Mois.	V.M.	F.C.	Ash	Sul.
13.2	1.8	89.00	9.2	0.60

Description of Tests

Nine tests were made on the effect of saturation temperature, starting at 50° C. or 122° F., and proceeding in steps of 2° C. to 66° C. or 151° F. The procedure adopted was to maintain test conditions in the producer for at least twenty-four hours before the test period so that conditions would become balanced before the data were taken. Fuel bed and ash depth were held as constant as possible and are shown in the accompanying contour drawings. Air flow was maintained the same throughout all the tests and represented an average rate.

To summarize, an effort was made to set up as nearly as possible a method of operation in which the saturation temperature was the only variable and, hence, any difference in results could be traced to that factor.

Five tests were run in which the depth of the fuel bed was varied: starting with a depth of approximately 75 in., the bed was decreased in steps of one foot until 27 in. was reached. These tests were conducted with a saturation temperature of 52° C. and

as in the previous tests every effort was made to hold contributing conditions constant.

Calculations

All calculations were made on a dry coke basis. The amount of gas produced was calculated from a nitrogen balance using the quantity of air and the analysis of the gas. Steam to the producer was obtained by calculation from the amount of heat necessary to raise the temperature of air.

A carbon balance was calculated for every run using the fixed carbon of the fuel as determined by proximate analysis as a basis. This method is not absolutely accurate but the difference would, no doubt, be constant and, hence, not appreciably affect the comparative results.

A series of curves has been drawn showing the results obtained from these tests, and it will be noted that in some cases a few points do not fall upon the curve as drawn. This, we believe, is due to inaccurate data rather than to anything unusual that might occur at these points. Also, a sample calculation has been included to show the method used in computing the results.

Discussion of Results

From an examination of the results obtained in these tests, it seems that some of the efficiencies calculated are high as, for instance, in the case of the run made at 56° saturation. This test shows a cold gas efficiency of 84% which is unusually high for practical operation. These errors are probably due to faulty measurement of the air to the machine and inaccuracies in calculating the carbon balance from the fixed carbon, since the coke used for this test had over 1% more volatile matter than the average. However, the main purpose of the tests is brought out by showing that there is an increase in B.t.u. output per pound of coke when the correct saturation temperature is used, due to the increased heating value of the gas produced and the additional gas formed by the decomposition of the steam.

All of the curves which show the efficiency of the producer have the same general shape, rising quite sharply to a peak at between 54° and 56° C. and decreasing rapidly as the amount of steam is increased. A B.t.u. drop in the gas of more than six is shown from the high point at 54° C. to the low at 66° C. The percentages of CO_2, CO and H_2 in the finished gas when plotted appear as would be expected, the CO decreasing with the addition of steam while the CO_2 and H_2 increased.

The curve in which the carbon in the ash per lb. of dry coke was plotted against the saturation temperature was especially interesting. The carbon loss showed a gradual increase as the amount of steam was increased until at a temperature of 62° C. the loss began to rise very abruptly.

The character of the ash showed marked difference, being composed of fused particles at the lower end of the temperature range, while at the upper end a sticky mud which was black with unburned carbon was the result.

The changes in efficiency resulting from variations in the fuel bed depth, while not so marked as in the case of the saturation temperature tests, were, nevertheless, positive enough to show that the fuel bed depth is an important factor in the operation of a producer. The deep beds gave a slightly better gas and the increased decomposition of the steam caused a slightly higher amount of gas to be made per lb. of coke.

CONCLUSIONS

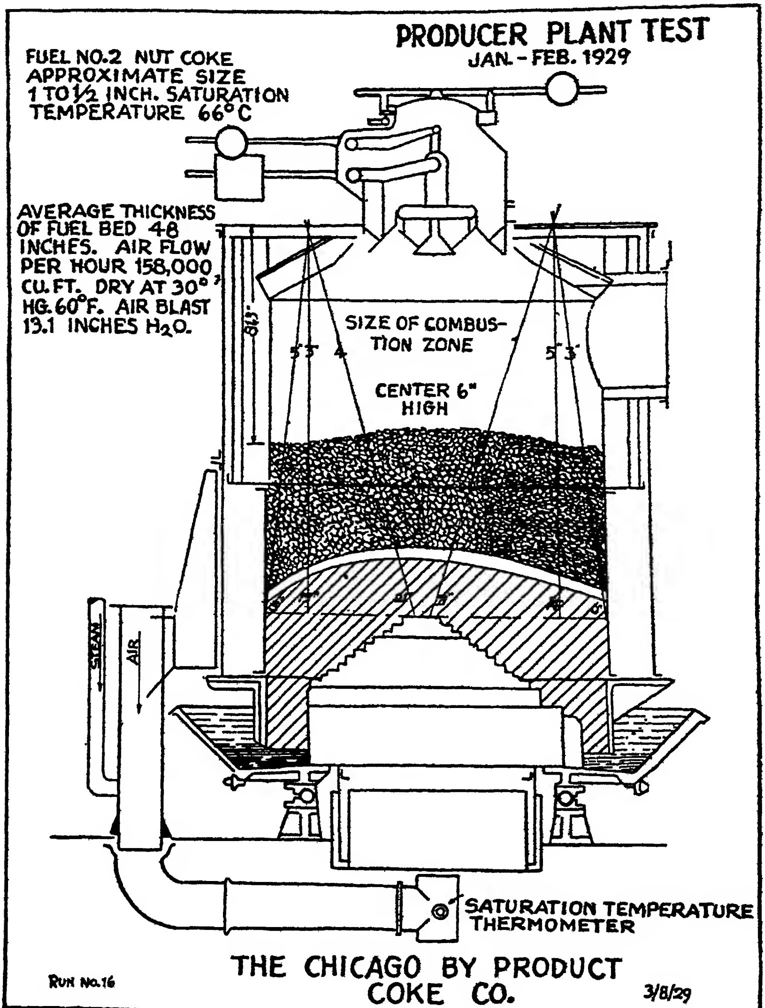
All of these tests were conducted at temperatures and fuel bed depths which could be maintained in practice without extra labor or attention, and while they were of too short a duration to draw absolutely accurate conclusions, still the fact is evident that for a given fuel there is a saturation temperature and fuel bed depth which will give the most efficient results in producer operation.

If raising the saturation temperature from 50° C. to 56° C. will show an indicated increase of 10% in B.t.u.'s recovered per lb. of coke and an increase in the fuel bed depth of approximately 2 ft. will show a gain of 3% in recovered heat, then it is evident that a study of this problem by producer operators would be of great value.

The most efficient temperature and fuel depth for a particular fuel can be readily determined by such simple tests as those outlined in this paper, and having determined the correct point a definite increase in efficiency and a lowering of production costs can be attained by the application of the test results to the operation of the producers.[8]

Mr. Locke's report is admirable because of the definiteness with which the procedure is explained and because of the stress laid on the fact that the tests represent, as he remarks, conditions "which could be maintained in practice."

[8] Reprinted by permission of the American Gas Association.



In other fields of practice other methods of explaining tests will be required, as the illustrations given below indicate. In each the qualities to be sought are clearness, conciseness, and comprehensiveness. Often the inclusion of the results in a table or in a graph will save both time and space, as appears in the following account (pp. 48-50) of tests on "Speed of Traf-

fic" in metropolitan Cleveland, from the *Report of a Plan of Highway Improvement in the Regional Area of Cleveland, Ohio* (Cleveland, 1928), by the United States Bureau of Public Roads and Cuyahoga County Commissioners:

(15)

In addition to the analysis of the volume, congestion, and distribution of motor vehicle traffic on routes in the regional area, a study of the time required for passenger car traffic to traverse the principal routes was made during average and peak-hour traffic periods.

These studies were made by means of a car equipped with a recording device which showed the actual speed at which the car was moving at all times, the mileage traveled in hundredths of miles, and the time required to cover the distance. Observers also recorded the causes of changes in speed during the test runs on each route. The car was operated so as to "float" with traffic and the data obtained therefore represent average traffic conditions during the period of each test run. Typical results of these time study runs are shown in Figures 17, 18, 19, and 20. [Figures 17, 19, and 20 omitted.]

The Public Square at Ontario Street was made a common point for the beginning of each time-study run, with Clague Road in the west, Royalton Road in the south and Green Road and the county line in the east as ending points for most of the test runs.

The lower average speed and the greater time required for a passenger car to travel during congested periods over routes within the city and suburban zones as compared with the average speed and time required to traverse sections of highways beyond these districts are indicated in Table 13 [omitted] and Figures 17, 18, 19, and 20. For example, the average speed of passenger car traffic on Euclid Avenue during congestion hours from the Public Square to Lakeview Road was 9 miles per hour, from Lakeview Road to Green Road 18 miles per hour, and from Green Road to the county line 31 miles per hour. On Detroit Avenue during the morning and late afternoon rush hours, the average speed from the Public Square to West 117th Street was 13 miles per hour, from West 117th Street to Wooster Road 10 miles per hour, and from Wooster Road to Clague Road 34 miles per hour. On U. S. Route 42 via West 25th Street from the Public Square to Broadview Road the speed averaged 14 miles per hour, while the average

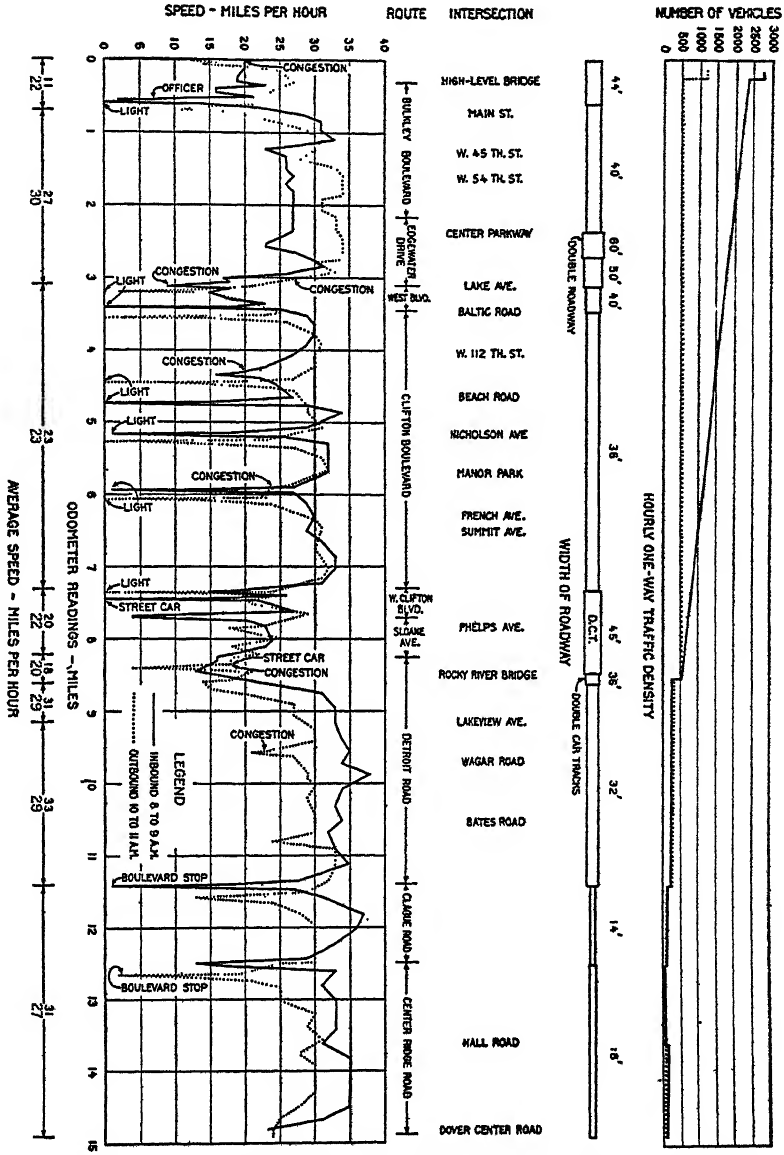


Figure 18. Hourly Passenger Car Traffic, Traffic Speed, and Roadway Width on Bulkley Boulevard, Clifton Boulevard, Detroit, Clague, and Center Ridge Roads (U. S. Route 20) from the Public Square to Dover Center Road (From the *Report of a Plan of Highway Improvement in the Regional Area of Cleveland, Ohio,* 1928)

TABLE 14. TRAVEL SPEED ON DETROIT AVENUE COMPARED WITH THAT ON THE BULKLEY BOULEVARD, LAKE AVENUE, AND WEST LAKE ROAD ROUTE

Detroit Avenue[1]						Bulkley Boulevard, Lake Avenue, West Lake Road					
Street cars, loading platforms, parking at curbs, motor truck traffic						No street cars or loading platforms and little parking or motor truck traffic					
From	To	Distance	Time		Speed	From	To	Distance	Time		Speed
		Miles	Min.	Sec.	Mi. per hr.			Miles	Min.	Sec.	Mi. per hr.
Ontario St.......	West 117th St....	4.63	21	5	13	Ontario St......	Bulkley Blvd. & Main St.	1.06	4	14	15
West 117th St....	Wooster Road....	3.66	21	48	10	Bulkley Blvd. & Main St.	Lake Ave. & Webb Road.	6.49	13	1	30
Wooster Road....	Clague Road ...	2.95	5	12	34	Lake Ave. & Webb Road	Wagar Road....	2.47	6	00	25
						Wagar Road....	Clague Road....	1.66	2	30	40
Total.......	....	11.24	48	5	14	Total.......	....	11.68	25	45	27

[1] The Detroit Ave. route compares favorably as to surface width with the Bulkley Blvd., Lake Ave., and West Lake Road route.

speed from Brook Park Road on the same route to the Royalton Road increased to 34 miles per hour.

Narrow streets, poor surface improvements, street cars, street car loading platforms, traffic control at street intersections, parking at the curbs, and heavy volumes of motor truck and bus traffic are the principal causes of the low average speed on sections of routes within the city and suburban zones.

A comparison of alternate routes extending west to Clague Road from the Public Square, as shown in Table 14, indicates the travel time lost by each passenger car operator because of these causes of delay on the Detroit Avenue route.

Although the distance is approximately the same for the two routes, there was a saving of 22 minutes in the eleven-mile trip for each car operator who traveled from the Public Square via Bulkley Boulevard, Lake Avenue, and West Lake Road to Clague Road as compared with the Detroit Avenue route.

In the field of business, the following account of a study of book-reviewing during a six-month period indicates how a writer may present the results of a test in an interesting manner. The section is taken from the chapter, "Book, Buyer, and Critic," by O. H. Cheney, in *Economic Survey of the Book Industry, 1930-1931, Final Report* (New York, 1931).

(16)

WHAT BOOKS ARE REVIEWED? In a recent six-months' period, out of a total of 4098 new titles published, 1733 received some critical attention in a list of 67 reviewing publications, including 14 media of general circulation, or 42 per cent. Percentage of titles published which were reviewed were, in each class, as follows:

Fiction	81.8	Science, Technology	15.3
Biography	61.0	Philosophy, Ethics	43.1
Religion	16.8	History, Travel	67.4
General Literature	28.2	Useful Arts	27.6
Sociology, etc.	63.0	Fine Arts	76.0

The non-fiction proportion is high because the reviewing media included a number of professional and technical magazines. This group of periodicals included the more representative of the general reviewing media—those of wider circulation. No reviewing medium of a general nature gives critical attention to more than half the trade books—and most of the reviews usually go to fiction.

The percentages of fiction, juveniles, and popular biography to all books reviewed in the three leading weekly reviews are about: 60, 50 and 45. For the general run of newspapers, the ratio is nearer 70 per cent.

In the flood of books, it is surprising that so many receive any consideration at all.

Exercise: Sampling.—Prepare for a report a section on the sampling suggested by one of the following topics. Include all the facts necessary. For instance, in considering the average load of automobile traffic on a given street, refer to the method of selecting cars and trucks—as every fifth car or truck during every third hour—and the method of estimating the load, either by the number of persons in the car or by the capacity of the truck as indicated on the body.

The average load of automobile traffic on a given street; the blood pressure of students after two hours of study; the durability of automobile tires of different makes; the efficiency of a specific automobile oil; the fuel values of the coal from several mines; the degree of fatigue among workers in a college shop; the heart action of students after smoking; the effect of certain foods upon a number of laying hens; the physical condition of the freshman class; the purity of the well water in the neighborhood; the character of the bricks manufactured by a particular firm; the quality of the illuminating gas supplied by a local plant; the recreations of students; the respiration of students after meals; the strength of the concrete in a given road; the brands of dentifrice used by the student body; the newspapers read by workers in a plant or department store; the average income of farmers in a county; the ownership and value of radios in a community.

CHAPTER 13

EXAMINATION REPORTS—PHASES (CONTINUED)

Record of Field Inspections and Office Work.—The work of the field forces gathering data for an examination is usually presented in the finished report by means of tables, charts, and maps, but it is often advisable to include in the discussion of these data an explanation of how the studies in field and office were conducted. For instance, in planning the highways of the Cleveland area, to quote the *Report,* "an extensive reconnaisance of the entire area of the regional survey was necessary."

(17)

In each case the plan recommendations made in this report and shown in Figure 32 [omitted], for the extension of, or completion of gaps in, present routes; the opening of new routes; the location and construction of bridges; the location and construction of railroad grade crossing eliminations; and the elimination of highway grade intersections are based upon careful reconnaissance surveys and studies of the proposed improvements. By means of enlarged sections of topographic maps of the United States Geological Survey, paper locations and profiles of alternative solutions of each problem were made and then compared with conditions on the ground. Consideration was given to all engineering features, and in addition special attention was paid to the development in the vicinity of each proposed improvement, which might affect right-of-way matters. It is believed that the locations that have been suggested offer a satisfactory and economical solution of traffic distribution problems. Estimates of the probable cost of the suggested features were based on quantities computed from the paper locations.

Since the reader is shown clearly how thoroughly the work has been done, such a statement adds weight to the conclusions.

Again, the writer of the report may wish to indicate, as in the following selections, what procedure was followed in making an inspection or a field study. On the basis of the accuracy and thoroughness of the method depends the value of the study. Thus *A Plan of Highway Improvement* describes in detail the procedure for "obtaining complete information regarding the present condition of each section of highway in the area."

(17a)

The type, design, specifications, width, and date of construction of the existing surfaces on each section of highway were tabulated from construction records. These data were supplemented by careful condition inspections of each route, including the determination of surface roughness by the use of a roughometer, check measurements of surface thickness, observations of surface cracking, scaling, and shattering, areas patched or repaired, shoulder condition, drainage conditions, and other factors influencing the serviceability of the routes.

On the basis of these inspections routes were classified as to condition into the following classes:

A1. Pavements in good condition and supporting traffic. Surfaces of this class are reasonably smooth, show no evidence of failure, and are in such condition that they can be used as integral parts of future improvement.

A2. Pavements supporting present traffic but rough and irregular. Such pavements show no evidence of foundation failure, but require resurfacing to transform them into class A1 improvements.

B1. Pavements showing signs of disintegration or failure, but having reasonably smooth surfaces. These are suitable for use as subbases for new surfaces.

B2. Pavements disintegrating or disintegrated and having rough irregular surfaces. These show evidence of foundation failure, but are suitable as subbases for new surfaces of adequate thickness.

C1. Surfaces worn out or so thoroughly disintegrated as to be of no value in place. The material may have a salvage value after removal from the pavement and processing.

C2. Surface completely disintegrated. The materials comprising these surfaces have no salvage value.

TABLE 4. CLASSIFICATION OF MAJOR AND MEDIUM TRAFFIC ROUTES ACCORDING TO TYPE AND CONDITION OF SURFACE

Type and condition	Cuyahoga County		Lake County		Geauga County		Portage County		Summit County		Medina County		Lorain County	
	Major	Medium	Major	Medium	Major	Medium	Major	Medium	Major	Medium	Major	Medium	Major	Medium
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Brick and concrete:														
Satisfactory for 10 years or more	58.3	69.7	75.3	78.5	70.0	21.3	41.9	.....	65.9	32.5	48.2	100.0	26.1	31.2
Satisfactory for subbase	18.5	17.0	12.0	21.5	.....	26.7	9.2	30.4	13.9	.....	.....	.....	.....	.....
Salvable as material only	3.6	.....	.....	.....	.....	.....	14.6	.....	7.6	.....	.....	.....	.....	.....
Bituminous top:														
Satisfactory for 10 years or more	17.8	9.4	4.7	.....	30.0	38.3	18.8	40.4	12.6	62.4	.....	.....	43.3	39.4
Satisfactory for subbase	1.7	.....	8.0	.....	.....	13.7	15.5	18.6	.....	.....	51.8	.....	30.6	23.2
Salvable as material only	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Minor types:														
Satisfactory for 10 years or more	.....	2.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Satisfactory for subbase	.....	0.7	.....	.....	.....	.....	.....	10.6	.....	5.1	.....	.....	.....	4.3
Salvable as material only	0.1	1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total—miles	291.1	132.9	47.0	35 0	14.4	29 7	38 3	37 4	74.8	24.7	30 0	11.4	35 7	44.4

TABLE 5. CLASSIFICATION OF MAJOR AND MEDIUM TRAFFIC ROUTES ACCORDING TO SURFACE WIDTH

Surface width	Cuyahoga County	Geauga County	Lake County	Lorain County	Medina County	Portage County	Summit County	Total
Feet	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Less than 18	38.3	90 5	50 4	64.1	55 9	76.7	52.6	61.2
18–20	19.2	9 5	41 8	35 9	44 1	23 3	44.1	31.1
21–29	13.2	......	......	......	......	......	3.3	2.4
30–39	16.7	......	3.7	......	......	......	......	2.9
40 and over	12.6	......	4.1	......	......	......	......	2.4
Total	100.0	100 0	100.0	100.0	100 0	100.0	100.0	100.0
Total—miles	424.0	44 1	82 0	80 1	41.4	75 7	99.5	846 8

This condition classification, together with an estimate of the remaining life of the present surface, considered in conjunction with the traffic classification, determined the plan of improvement for present surfaces, except as to surface width. The present width of the surfaces compared with the required roadway capacity as determined by present and expected future traffic and the traffic capacity studies, determined the plan of improvement as to width.

The results of the detailed study of the major and medium traffic routes in the regional area in respect to type and condition are shown in Table 4, and in respect to surface width in Table 5. Both types of information are shown on the map, Figure 30 [omitted]. . . .

To facilitate the analysis of the mass of evidence considered in planning the improvement of the existing routes, all data available for each route in the area were assembled on log sheets, of which a typical sample is shown in Figure 31 [omitted]. This form summarizes all the facts as to the present roadway, the traffic which it carries, and the condition and estimated life of the present roadway. Similar data and forms were compiled for each route in the area.

Interpretation of Interviews.—It has already been pointed out that interviews deal with opinion or with fact; that, ordinarily, when the person interviewed occupies an executive position of any importance, the conversation will turn on matters of policy; and that, when his position is merely clerical or mechanical, it will deal with specific data.

The section in the report which contains the results of an interview of the kind first mentioned will consist of generalizations. It will be distinctly impressionistic. For instance, in their *Report* on the St. Lawrence Waterway, the members of the International Joint Commission include a paragraph summarizing public opinion in the United States and Canada regarding the proposed ship canal:

(18)

An analysis of the testimony submitted makes it clear that the consensus of opinion in the two countries as revealed at the public hearings, while far from unanimous, was on the whole distinctly favorable to the proposed improvement of the St. Lawrence.

Broadly speaking, it may be said that public sentiment throughout the Middle Western and Western States from Ohio to Idaho was almost unreservedly in favor of the deep waterway. The only evidence submitted on behalf of the people of the Mississippi Valley was also favorable. Various organizations and individuals in the Eastern States expressed themselves as approving of the project. On the other hand, evidence was not wanting of a widespread sentiment in some of the Eastern States antagonistic to the project. On the Canadian side, anything like general approval of the undertaking was confined to the Province of Ontario. In the other Provinces, public sentiment appeared to be either indifferent or more or less hostile.

The form of this quotation is substantially that employed wherever it is necessary to reproduce at a distance the impression left by an interview in which notes were not taken.

Where the purpose of interviews was to secure specific information, and where notes were taken to preserve it, they are presented in the report almost literally. For example, in the *Regional Survey of New York and Its Environs,* Vol. VII (New York, 1929), it became necessary to record the opinions of specialists on the bactericidal and therapeutic effect of sunlight. These opinions, gathered in hearings held several years before by the New York Commission on Building Districts and Restrictions, were presented (p. 150) in the *Survey* by means of quotation and comment. They represent the common technique for the presentation of the results of hearings and interviews.

(19)

Dr. Haven Emerson, in testimony before the Commission on Building Districts and Restrictions, said, "Congestion is a term that can be twisted variously. Diminished resistance of human beings, as with vegetation, depends upon the artificiality of their environment. You cannot raise babies any more without light and air, than you can raise plants, and where you cannot prove that a disease has followed congestion, you can almost always show diminished resistance."

The late Professor George C. Whipple, of Harvard University, testifying before the same Commission, called attention to the fact that sunlight falls obliquely upon land and that wind movements

are chiefly horizontal. These natural elements are interfered with by high buildings; thus there are certain rights in land ownership which extend beyond the vertical planes. Sunlight affects ventilation by causing gentle movements of the air, due to the unequal heating by the sun in different places. Sunlight disinfects, prevents mold and fungi, eliminates odors, destroys bacteria, and thus has great physiological and psychological influence on human beings. He further pointed out that diffuse sunlight or daylight is likewise indispensable to man. Lack of it develops eye strain, necessitates artificial light, vitiates the air; if gas or oil are used as substitutes, they increase fire risks, decrease vitality and productiveness, increase the amount of window space required and thus result in heat loss in buildings in winter. "In these ways," Professor Whipple said, "insufficient lighting not only results in inconvenience to human beings, but may be a positive menace to the health, safety and morals of the people."

Rudolph P. Miller, Consulting Engineer, testified before this Commission stating that practicable artificial light and ventilation could satisfy the requirements of eyesight and provide pure air, but could not fully replace sunlight as a pathogenic agent.

Any such excerpts are bound to be impressionistic rather than authoritative. Consequently, where evidence gained from testimony, letters, or interviews is to be published in a report, it is well to follow the procedure of the *Regional Survey:*

(19a)

While the space available does not allow quotation from all of them, excerpts from a few more may be added. Dr. Janet Howell Clark, of the School of Hygiene, Johns Hopkins University, for example, says "there is no doubt that sunlight can cure or prevent rickets and some types of tuberculosis." Later in the same statement, she continues: "Questions as to man's dependence on sunlight for health are difficult to answer. The effect of sunlight is tied up with the effect of diet and probably on a perfect diet man could live without sunlight, but sunlight (i.e., direct sunlight) protects against one disease due to infection (tuberculosis) and is probably a safeguard against many ills to which we are continually exposed."[1]

Dr. Howard Lo Grasso, of Perrysbury, New York, another investigator in this field, writes as follows:

[1] For full statement by Dr. Clark, see p. 204.

"Perhaps the best controlled experiments in regard to sunlight and health are the work of Simons, of Johns Hopkins University, who studied the matter from the standpoint of production of rickets. There can be no doubt as to the effect of light energy in the prevention and cure of this condition. Hess and Unger of the Montefiore Home, New York City, have demonstrated the curative effect of ultra-violet radiation on rickets."[2]

[2] For full statement by Dr. Lo Grasso see p. 206. The complete statements of these authorities are printed in an appendix, pp. 202-209.

In a similar fashion Mr. W. P. Hedden, Chief of the Bureau of Commerce, Port of New York Authority, reporting on "Vertical Clearance and Lateral Clearance for the Midtown Hudson Tunnel," used the method of interviews and questionnaire letters throughout. In his appendices Mr. Hedden lists the firms and individuals interviewed and reproduces significant letters and summaries of interviews. A quotation from his Report on *Motor Vehicle Heights* will indicate the method used in gathering the information into usable form:

(20)

Experience of Hudson River Ferries

One ferry operating across the Hudson River south of Tarrytown can accommodate vehicles with a height of 13 feet 6 inches. All others have lesser clearances.

	Vehicle Height Limit	
Electric Ferries, Inc.	13′	6″
C. R. R. of N. J.	12′	6″
Erie R. R.	12′	4″
Pennsylvania R. R.	12′	4″
D. L. & W. R. R.	12′	2″
West Shore R. R.	12′	0″
Dyckman Street	11′	9″
Fort Lee	11′	6″

Several ferries operate special services for trucks with exceptionally high loads by allowing such vehicles to board the rear open deck, where no limitation in height exists. The ferry is turned about in mid stream and backed into the slip, permitting the vehicle to back off the rear.

The ferries make a special charge for this service, as per typical quotations from the D. L. & W. ferry tariff: "Vehicles measuring more than 12′ 2″ in height, or 9′ 6″ in width, will not be transported on ferries except by special agreement. When the car or vehicle to be transported necessitates the turning of boat a charge of $15.00 (in addition to charge for ferriage authorized herein) will be made."

The charges for this service on the various ferries are as follows:

D. L. & W. R. R.	$15.00 plus
Pennsylvania R. R.	22.50
Erie R. R.	25.00
West Shore R. R.	25.00
Electric Ferries, Inc.	25.00

The experience of the Electric Ferries, Inc., is particularly significant because this route has the maximum clearance on the river, normally 13′ 6″, with a possible absolute maximum of 14′ if interior lights are removed. The ferry bridge on the New York City side also limits vehicles to 14′.

The Electric Ferries, Inc., keeps no record of the number of vehicles carried which exceed the nominal maximum vertical clearance of 13′ 6″, but the General Manager's office estimates the volume of this special traffic to be from 150 to 200 vehicles per year, representing mostly exceptional loads such as have already been described.

This extract gives a summary of the facts and opinions secured from a series of interviews and in one instance specifies the special experience of an individual concern. It illustrates an effective method for presenting matter-of-fact evidence secured in interviews.

Exercise: An Interview.—After formulating a plan of campaign and interviewing one of those mentioned below, prepare a summary of the result.

An athlete on his method of keeping fit; a business manager of a college paper on his plans for securing advertisements; an employee on the prevalence of a socialistic attitude among the unskilled laborers in a factory; a clergyman on the reasons why students should attend church; a physical director on the effects of breaking training; a student on the advantages of living in a fraternity house; a student on the results of the honor system.

As a variant of the single interview suggested above, each student may choose at random ten or fifteen interviewees and consolidate in his report the results of a group of interviews. Such topics are: drinking habits of students; attitude toward piece work in a plant; value of comprehensive examinations as a requirement for graduation; reading habits of students or employees in a plant or other institution such as a bank, a retail store, or an office; automobile drivers on ways of preventing highway accidents; executives on qualities most desired in employees.

Interpretation of Questionnaires.—In interpreting in the report the answers to a questionnaire, it is necessary to indicate, as explained in the criticism of Professor Leuba's treatise, the character of the group to whom the questionnaire was submitted and the nature of the process by which certain individuals were selected to represent the others. The value of the generalizations will depend largely upon these factors. According to the Department of Agriculture, the average farmer in the United States had a cash income in 1922 of only $715. Since this figure is based upon a survey of 6,094 farms out of the millions to which it applies, it is evident that the way in which they were selected is of prime importance. Were they drawn from the backward districts of the East? From the fertile areas of the Middle West, where machinery is invariably employed? From the rambling plantations of the South? From the irrigated sections of the Pacific Slope? These and a hundred other questions must be anticipated. The Sage Foundation recently completed an investigation, based upon conditions in 5,000 homes, of the financial status of the average city family. Are these 5,000 homes typical or not? In the section of a report which undertakes to interpret the answers to a questionnaire, it is customary to meet queries of this kind by describing the position of the group to whom the questionnaire refers and the lottery—for such it is—by which certain members of the group were chosen to represent it.

In the report, the questionnaire itself must be reproduced either in its original form or in abstract. The answers to the questions contained in it may be interpreted in two ways.

If there are few divergencies, the replies may be summarized in brief generalizations containing references to any not-

able deviations from the norm. Appendix L, of the "Report of Committee V—Track," *Proceedings* of the American Railway Engineering Association for 1935 on "Desirable Tightness of Track Joints and Effect upon the Life of Rails and Joints of Overtight Joints; of Loose Joints" is treated in this manner:

(21)

The following questionnaire was sent to all railroads represented in the A. R. E. A. to ascertain their practice, experience, and opinions on this subject.

1. What is "desirable tightness" of track joints to obtain maximum life of rail joints?

2. How do you determine "desirable tightness" of track joints?

3. What effect have overtight joints on rail, such as:
   (a) Battered ends?
   (b) Wear on fishing surfaces?
   (c) Breakage through bolt holes, etc.?

4. What effect have loose joints on rail, such as:
   (a) Battered ends?
   (b) Wear on fishing surfaces?
   (c) Breakage through bolt holes, etc.?

5. To what extent is the life of rail shortened by:
   (a) Overtight joints?
   (b) Loose joints?

6. To what extent is the life of joints shortened by:
   (a) Overtight joints?
   (b) Loose joints?

7. Does the use of spring washers or joint springs have any effect on overtightening?

Answers were received from thirty-five railroads. These answers are such that a brief summary cannot be made and a complete copy of them would be quite voluminous.

Opinions given for "desirable tightness" vary from 7,000 lb. to 20,000 lb. per bolt.

The majority opinion, however, as given in the answers to the questionnaire is summarized in the following:

CONCLUSIONS

1. DESIRABLE TIGHTNESS OF TRACK JOINTS

Desirable tightness of track joints is that degree of tightness in which the bolts are kept as tight as possible, and still permit the rails to move uniformly with contraction and expansion. This can be obtained by the average trackman exerting his full strength on a forty-two to a forty-eight inch wrench, depending on the size of bolt, kind of threads and condition of bolt, and by frequent inspection and careful maintenance.

2. EFFECT UPON THE LIFE OF RAILS AND JOINTS OF OVERTIGHT JOINTS

With overtight joints there is a tendency for rails to kink and for batter to be excessive at the wider joint openings, due to distribution of expansion not being uniform. This, however, will have little effect generally upon the life of the rail as a whole. The life of the joints will be increased because the tightness will tend to reduce to a minimum the movement of rails and joint assembly, thereby reducing wear.

3. EFFECT UPON THE LIFE OF RAILS AND JOINTS OF LOOSE JOINTS

Loose joints cause excessive batter of rail ends; cause surface bent rails; cause abnormal wear on both rails and joints, thereby materially shortening the life of both; and are responsible for a very large portion of the labor cost of maintenance.

The Committee offers this report as information and recommends that the subject be discontinued.[1]

The advent of the survey as a means of gathering sociological, educational, and economic data has brought into prominence the report based almost wholly on information collected by means of questionnaires. One of the foremost illustrations of the type is the *Report of the Investigation of Engineering Education* (Pittsburgh, 1930), in two volumes, of which no less than 14 individual studies were carried on either wholly or in part by this method. Either at the beginning or the end of such reports it is customary to summarize the replies in a paragraph or two of generalization. For example, in the report, *The Leisure Hours of 5,000 People* (New York, 1934), pre-

[1] Reprinted by permission of the American Railway Engineering Association.

pared by the National Recreation Association, the first three pages are occupied by a summary from which the following extract may be taken as typical of the method ordinarily followed:

(22)

. . . As a means for securing the information desired a questionnaire was prepared and distributed in which were listed 94 free time activities, 37 home, and 57 outside activities. A total of 5,002 persons in 29 cities of different types and sizes submitted replies. The report is based largely on these replies and also upon interviews with individuals and agencies. Returns were secured through many types of organizations and from a wide range of occupations. More than 80% of the replies were from persons 21 years of age or older. Forty-three per cent were employed full-time, 28% part time and the others either occasionally or not at all.

The sum of the activities reported taken part in by the 5,002 individuals during the previous year totalled 126,442 or an average of 25 activities per individual. Of these 12 were home and 13 were outside activities. Activities taken part in *often* were also recorded separately. They averaged 11 per individual—6 home and 5 outside activities. The ten activities reported by the largest number of individuals and also the ten reported taken part in *often* are listed in rank order.

TOTAL PARTICIPATION

Activities	No. Reporting
Reading newspapers and magazines	3,977
Listening to radio	3,955
Attending the movies	3,670
Visiting or entertaining others	3,445
Reading books—fiction	3,408
Auto-riding for pleasure	3,246
Swimming	2,976
Writing Letters	2,899
Reading books—non-fiction	2,847
Conversation	2,735

FREQUENT PARTICIPATION

Activities	No. Reporting
Reading newspapers and magazines	3,244
Listening to radio	2,842
Reading books—fiction	2,155
Conversation	2,141
Reading books—non-fiction	1,776
Auto-riding for pleasure	1,765
Visiting or entertaining others	1,672
Attending the movies	1,642
Swimming	1,603
Writing letters	1,158

The most common types of leisure time activity, based on the replies, are for the most part home activities, inexpensive, indoor, individual, quiet or passive. Except for reading and swimming, the influence of community recreation or educational agencies is not apparent. Interestingly the ten activities taken part in by the

largest number of people are also the ten in which greatest frequent participation is recorded although the rank order is not the same. Two items involving expense—movies and swimming—drop in rank in the list of things done *often*. Activities involving music, art and drama, and most games, sports and outing activities have a relatively low place in the list of 94 activities ranked in order of the number of people taking part in them. If it could be assumed that people are already doing the things they most enjoy doing, it might seem that the recreational facilities and leadership service provided by public and private agencies are of relatively small importance. A study of people's desires, however, indicates that this is not the case.

Where there are many variations in the number and character of the replies, and where it is difficult, therefore, to summarize them in a general statement, a tabular arrangement such as that illustrated by the following extract from the "Report of the Subcommittee on Retail Sales" *Proceedings* of the American Gas Association for 1932 is advisable:

(23)

The response to the questionnaire sent to 30 companies doing over 85% of the sales volume on retail sales of gas refrigeration has proved to be very interesting and decidedly enlightening. The methods used are so different in most cases that your committee has included in this report the complete tabulation of these results. . . . Twenty companies replied. From these 20 answers to the questionnaire the following information is gleaned. (The outline below follows the form of the questionnaire.)

A. Number of salesmen: (a) Wholesale? (b) Retail? (c) Combination?

A. Out of the 20 companies reporting:

12 have wholesale salesmen—averaging 3.6 men.

8 have no wholesale salesmen—use combination men.

Retail salesforces average 20 men.

B. Are these salesmen selling refrigeration exclusively? What other appliances do they sell?

B. Only 4 companies report that their retail salesmen sell refrigeration exclusively. (This is quite surprising, in view of the presumably accepted view

that gas refrigeration is a special field—requiring special salesmen—special training, etc.) Of these 4 companies—2 are small and 2 are large, so that size has nothing to do, evidently, with policy on this matter. 1 company reports salesmen sell refrigeration and house heating. 14 companies report salesmen sell all domestic gas appliances.

C. How are salesmen compensated? (a) Straight commission? (b) What rate? (c) Salary and commission? (d) How much each? (e) Bonuses? (f) Same compensation winter and summer? What requirements do your salesmen have to meet to hold the job?

C. 7 companies pay straight commission of from 10% to 15%.

13 companies pay salary and commission. Of these 13 companies:

3 companies pay around \$50 per month plus 8% to 10% commission.

5 companies pay around \$75-80 per month plus 4% to 8% commission.

5 companies pay around \$100 or more per month plus 5% or 6% commission.

Requirements mentioned to get on sales force, "a desire to work and be successful," "some selling experience," etc.

Requirements mentioned to stay on sales force (which was the question given) were "satisfactory results," "reasonable average sales," "must make money," "make their allotted quota" and similar indefinite requirements. However:

6 companies state a minimum sales production of \$1,000 to \$1,500.

All companies pay same compensation winter and summer.

Exactly half of the reporting companies report the use of some bonus plan (generally limited to special campaigns, but not always the case).

Most of these bonuses run from \$2 to \$5 per box.

D. Servicing Data: (a) What is guarantee? (b) Do you guarantee "within 2 hours of time of request"? (c) What is your service cost per box per year? (d) What

average per year on number of service calls? (e) What is greatest service complaint?

D. 7 companies give a 2-year guarantee.
6 companies give an indefinite guarantee.
1 company gives a 1-year guarantee.
2 companies give a 5-year guarantee.
2 companies give a 3-year guarantee.
13 companies do not guarantee 2-hour service.
3 companies do not guarantee it, but give it.
4 companies guarantee it.
Service cost per box per year averages $4.
Service calls per box per year range from 1 to 4—average 2.7.
Greatest service complaint:
8 companies state burner cleaning and adjustment.
7 companies state water trouble (control or consumption).

E. What are your regular selling terms: Retail? Price? Finance charge? Special terms? What is your wholesale price on 1—2?

E. Greatest time:
36 months—1 company.
30 months—1 company.
24 months—14 companies.
18 months—1 company.
Finance charges:
11 companies—6% interest.
3 companies—7½% interest.
1 company—5½% interest.
1 company—4% interest.
1 company—3% interest.
Wholesale:
5 companies sell at 20% discount.
5 companies sell at 30% discount.
3 companies sell at cost plus 10%.
1 company sells at cost.[2]

It is often possible to include much of the information contained in a questionnaire in a table or a graph or both, as the following illustrations show.

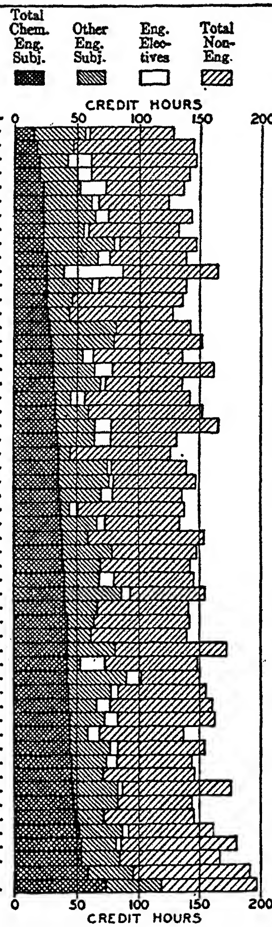
[2] Reprinted by permission of the American Gas Association.

Summary of Appliance Service Policies of Twelve Companies—April, 1932

(Answers to Questionnaire of April 20, 1932. The individual answers for only six companies are given here.)

	1	2	3	4	5	6	
Company	*Is Free Service Supplied to Keep Appliances in Condition?*	*Are Charges Made for Any Service Supplied to Keep Appliances in Condition?*	*Are Customers Ever Asked to Obtain Necessary Appliance Service From Others as Plumbers?*	*Would It Be Desirable to Inaugurate a Charge for Any or All Service Now Supplied Free?*	*Is a Charge for All or a Part of the Present Free Service Planned for the Future?*	*Have Costs of Free Appliance Service Increased Because of Automatic Appliances?*	*Remarks*
A.	Yes	Material at cost.	Only for repairs not on appliances or gas pipe.	No	No	1931 costs double 1930.	Rate includes an amount a little over 1c/M for this work which is considered necessary to maintain sales.
B.	Yes Burner adjusting only.	All appliances bought from company serviced free for one year; all burners adjusted free; flat rate charge for all other work for labor and material.	Only for cases where manufacturers request service calls; repairs not directly in province of gas co. referred to plumbers, steam fitters, etc.	No	No	Yes	Present scheme of charging for all work except burner adjusting inaugurated 3/1/31.
C.	Adjustments and minor repairs requiring no parts and ½ hr. or less of time are free.	Material and time over ½ hr. charged for at flat rate covering time and material.	Takes care of all emergency service but advises that outside agencies make major repairs.	Inaugurated present charges 2/15/32.	Just started charging for part of the service.	Yes	One hour free labor allowed on house heating jobs. After 1/1/32 refrigerators will not receive free service whether sold by company or other dealers.
D	Yes Everything within reason.	Cleaning except burners. All repairs except those covered by guarantee.	Yes for work on water lines and that which gas company cannot do itself.	No	No	No	Expects increase due to automatic appliances. Have just gone through a change-over period which fosters disposition to do more free work for the time being.
E.	Yes	For parts only	Do not recommend plumbers for work needed to be done.	Thinks it would be folly to inaugurate charges where rate is sufficient to cover this cost.	No	Yes—25%	
F.	Yes	No	No	No	No	Yes	Recent change-over tends towards leniency of this co.
General Summary	8 give general free service; 4 adjust burners only and 2 charge for all time over a specified minimum.	1 does not charge for any service; 10 charge for material; 1 does not handle parts; 2 charge for cleaning; 1 charges for time over ½ hr.; 1 charges for time over ¼ hr.	9 recommend plumbers for work beyond province of gas co.; 1 does work at customer's option; 2 do all work.	1 feels that some free items might be charged for; 1 recently inaugurated a policy of charging for some items which were free; 9 feel there should be no change in policy.	1 has matter of charging more under consideration; 10 are not considering a change.	10 have had increases in service costs; 2 have had no increases in these costs but one of these has been involved in change-over so costs records may be misleading.	

(From "Present Day Practice in Customer Service," *Proceedings* of the American Gas Association for 1932, p. 805)



	Names of Institutions	Total Grad. Req.	Total Chemical Eng. Subj.	Other Eng. Subj.	Eng. Elect.	Total Non Eng. Subj.
1	University of Missouri	128	15	43	4	66
2	North Carolina State College	146	18	30.7	0	97.3
3	University of Alabama	147.5	20	23.5	20	84
4	University of Michigan	140	20	30	11	79
5	University of California	136	24	29	21	62
6	University of Nebraska	125	24	40	6	55
7	University of New Mexico	144	24	43	10	67
8	University of Tennessee	133	24	33	3	73
9	West Virginia University	148	24	58	5	61
10	University of Arkansas	139	26	42	9	62
11	Colorado School of Mines	165	26	13	48	78
12	Princeton University	138	26	37	6	69
13	Swarthmore College	137	26	22	(4)*	89
14	University of South Dakota	128	27	18	(9)*	83
15	University of Colorado	142	29.3	53.3	0	59.3
16	University of Idaho	152	30	51	0	71
17	Yale University	136	32	25	9	70
18	Notre Dame University	163	32	35	14	82
19	University of Florida	136	33	39	3	61
20	University of New Hampshire	143.3	34.7	12.6	12	84
21	Virginia Polytechnic Institute	152	34.7	27.1	—	90.2
22	Purdue University	167	35	32.3	13	86.7
23	University of Washington	132	35.3	31.3	12.7	52.7
24	State College of Washington	128	36	9	0	83
25	George Washington University	140	36	40	2	62
26	Carnegie Institute of Technology	148.6	36	42	3	67.6
27	Michigan State College	136	36.7	34	8.7	56.6
28	Oregon Agricultural College	138	37	7.3	7.7	86
29	Tufts College	135	37	31	6	61
30	University of Delaware	153	38	22	0	93
31	Syracuse University	149	38	42	0	69
32	Georgia School of Technology	142.4	39	31	0	72.4
33	University of Minnesota	145.3	39.3	28.7	12.6	64.7
34	Ohio State University	155.3	39.3	47.3	7.4	61.3
35	University of Kansas	141	40	27	0	74
36	Louisiana State University	141.3	42	22.6	—	76.7
37	University of Maine	140	42	21	(13)*	77
38	Lehigh University	173	42	40	0	91
39	Bucknell University	149	42	12	20	75
40	University of Wisconsin	150	42	49	12	47
41	Lafayette College	156	43	36	6	71
42	Alabama Polytechnic Institute	161.4	43.5	22.3	12	83.6
43	A. & M. College of Texas	164.5	44	29.5	12	79
44	University of Illinois	137	45	16	10	66
45	University of Pittsburgh	155	45	33	7	70
46	Iowa State College	144	46	28.7	9.3	60
47	Montana State College	145.3	46	26	(24.6)*	73.3
48	Massachusetts Institute of Tech.	178.2	47.5	35.7	4	91
49	Rose Polytechnic Institute	143	48	37	(23)*	58
50	Clarkson College of Technology	143.3	49.3	24	0	70
51	Tulane University of Louisiana	162	52	35	6	69
52	Polytechnic Institute of Brooklyn	181	54	29.5	4	93.5
53	Case School of Applied Science	167	54	32	0	81
54	Catholic University of America	190.5	60	37.5	0	93
55	Armour Institute of Technology	195.5	73.5	45.5	—	76.5

* Options—not included in Total Graduation Requirements.

Total Semester-Hour Requirements in Principal Subject Groups, Chemical Engineering Curricula

(From "A Study of Engineering Curricula," *Report of the Investigation of Engineering Education*, Pittsburgh, 1930, Vol. I, p. 509)

Graphic devices, as well as tables, may be used to advantage in interpreting the replies. Indeed, tables, charts, and generalizations are often combined with happy effect.

Exercise: A Questionnaire.—Prepare a questionnaire, containing not more than ten questions, on one of the following topics. Submit it to ten

persons who are likely to reply, and then interpret the results by means of tables, charts, and generalizations.

A questionnaire, addressed to architects, on the cost of construction now as compared with that six months ago; to automobile owners on the efficiency of motor oils; to automobile owners on the endurance of various kinds of tires; to contractors on the relative cost of constructing residences of brick or lumber; to farmers on the income per tree from an orchard; to farmers on the number of live stock on the average farm in their district; to librarians on the calls for various kinds of books; to mine operators on the relative efficiency of different safety devices; to miners on the number of hours per day and the number of days per year on which they are employed; to students on the amount of outside reading which they do in a week; to students on the extent to which they purchase articles advertised in college publications; to students on the items of expense in their weekly budgets; to students on the number of hours a day which they devote to study; to students on the reasons why they do not attend church oftener; to students on the amount of tobacco which they use in a week; to students on their leisure time activities; to wholesalers on their returns from mimeographed sales letters; to merchants on sales of advertised brands of commodities.

Acknowledgment of Indebtedness.—Since a large part of the material in every examination report is dependent upon the assistance of those who have aided the writer, an acknowledgment of their kindness is always fitting. Although such a recognition may be little more than an act of courtesy, it has been prescribed by custom, a mistress whose decrees are as inviolable in writing as in conduct. The acknowledgment may be general or specific; that is, the writer may merely mention the names of those who have aided him or he may indicate explicitly the manner in which they have coöperated.

In his *Report to the New York State Bridge and Tunnel Commission and the New Jersey Bridge and Tunnel Commission,* Mr. Holland remembers his engineering staff and the Board of Consulting Engineers:

(24)

In conclusion, your engineer desires to record his indebtedness for the valuable services rendered by the members of the engineering staff, particularly Principal Assistant-Engineer Jesse B. Snow, Resident Engineer Milton H. Freeman, and Designing Engineer

Ole Singstad, and for the hearty coöperation and advice of the Board of Consulting Engineers.

In its composite *Report on the Economic and Social Problems and Conditions of the Southern Appalachians,* United States Department of Agriculture Miscellaneous Publication No. 205 (1935), the Department of Agriculture devotes a page to an account of the organization of the committees, general, coöperating, and technical, which carried on the study and lists the personnel and rank of the members. In addition, it indicates the services rendered by each committee and by a number of individuals.

(25)

The services of a number of persons in the Bureau of Agricultural Economics merit special mention.

L. J. Peet, Division of Land Economics, carried the chief responsibility for checking, organizing, and systematically arranging the materials prepared and submitted by the various contributors to the publication.

Special acknowledgment is also due R. G. Hainsworth, in charge, Graphics Section, who planned and supervised the preparation of the graphic material.

The topographic map of the Southern Appalachians was prepared especially for this publication by F. J. Marschner, Division of Land Economics.

J. Clyde Marquis, in charge, Division of Economic Information, contributed valuable criticisms and suggestions with respect to the preparation and arrangements of materials.

Where analyses and tests, for instance, have been made by other specialists, references must be full and exact. In a few reports—for instance, the *Interim Report,* Power Series, No. 1, of the Federal Power Commission—the entire personnel of the staff is listed, with a brief statement concerning the training and experience of each member.

Arrangement of the Conclusions.—At first it might seem as if the acknowledgment of indebtedness ought to appear at the end of the report. In practice, however, this position is usually reserved for the conclusions. The principle of emphasis thus has right of way over that of order. For the same reason,

conclusions are frequently placed at the beginning of the report instead of at the end. Where the aim has been expressed by a series of questions framed either by client or expert, this arrangement is generally adopted. Wherever they are placed, the conclusions are presented as either (1) a summary or (2) a series of details.

In the *Final Report of the International Joint Commission on the Lake of the Woods Reference,* the three questions are repeated and then discussed in the light of the facts established by the examination. The first of these three divisions is quoted:

(26)

CONCLUSIONS AND RECOMMENDATIONS: QUESTION I

> In order to secure the most advantageous use of the waters of the Lake of the Woods and of the waters flowing into and from the Lake on each side of the boundary for domestic and sanitary purposes, for navigation and transportation purposes, and for fishing purposes, and for power and irrigation purposes, and also in order to secure the most advantageous use of the shores and harbors of the Lake and of the waters flowing into and from the Lake, is it practicable and desirable to maintain the surface of the Lake during the different seasons of the year at a certain level; and if so, at what level?

INTERPRETATION

A strict interpretation of the first part of this question would necessitate a reply in the negative. In view of the great variation in precipitation occurring from year to year, the maintenance of an absolutely uniform level of the Lake of the Woods, over long periods of time, is not practicable, nor is it desirable, because it would not admit of the most advantageous use of the waters flowing into and from that Lake.

Having in mind, however, the origin of the questions of the reference, it is clear that a "certain stated level" refers nevertheless to a relatively uniform level.

REGULATION DESIRABLE

A careful study of the physical data submitted in the report of the consulting engineers and a consideration of all the interests involved lead to the conclusion that it is practicable and desirable to maintain the Lake at a relatively uniform level throughout all ordinary seasons; but that in order to secure the most advan-

tageous use of the waters flowing from the Lake, it is necessary to permit a draft on the water stored in the Lake, in excess of 2 or 3 feet, during periods of exceptional drought occurring about once in 20 years for the purpose of maintaining a satisfactory outflow and also to permit the storage of some of the flood water above the ordinary maximum level during occasional years of excessive flood inflow.

THE RECOMMENDED LEVEL

Because of diverse requirements of the various interests, it is an impossibility to recommend a level or regimen of levels which would be of equal desirability to all these interests. After careful consideration of all the factors entering into this problem, the Commission is of the opinion that, subject to proper compensation and protection being provided for property and interests injuriously affected, the most advantageous use of the waters of the Lake of the Woods and of the waters flowing into and from that Lake and of the shores and harbors of the Lake can be secured by maintaining the level of the Lake at an ordinary maximum stage of 1,061.25 sea-level datum. Whenever the level of the Lake rises to 1,061.0, sea-level datum, water shall be wasted or conserved as directed by the Commission, under the system of international supervision and control hereinafter recommended, and between 1,056 and 1,061 water may be drawn from the Lake by the appropriate authority in Canada for the benefit of Canadian interests, provided, however, that the level of the Lake shall not, even toward the end of a series of dry years, be drawn below 1,056 sea level datum without the approval of this Commission, and then only on such terms and conditions as it may impose.

The Commission is further of the opinion that if the additional storage hereinafter recommended for the Upper Rainy watershed is provided, the ordinary maximum level can be slightly increased without injury to any interests on the Lake and with material benefit to the water power interests both at and below the outlets. This can be done within the limits of the flowage rights to contour 1,064.

The term "level of the lake" wherever used in this report shall be construed to mean the level of the open lake unaffected by wind or currents.

Entirely different in form are the conclusions in the *Report of the Commission to Study the Proposed Highway to Alaska* (Washington, D. C., 1933), which are presented (pp. 1-3) as a series of details:

(27)

I. Conclusions and Recommendations

The Special Commissioners appointed by the President of the United States for a study regarding the construction of a highway to connect the northwestern part of the United States with British Columbia, Yukon Territory, and Alaska have reached the following conclusions:

1. The highway is a feasible project and can be built at a reasonable cost, which should not exceed $2,000,000 for the Alaska section and $12,000,000 for the Canadian section.

Route	Completed road	New construction needed	Total
Seattle to Hazelton, British Columbia...	882	0	882
Vancouver to Hazelton, British Columbia	830	0	830
Hazelton to Yukon Boundary..........	50	520	570
Yukon Boundary to Alaska Boundary...	50	480	530
Alaska Boundary to Fairbanks.........	91	183	274
Seattle to Fairbanks..................	1,073	1,183	2,256
Vancouver to Fairbanks...............	1,021	1,183	2,204

2. If the project is adopted, the stage-construction process is favored. That is to say, the initial standard should be no higher than is required for the estimated traffic, and improvements to higher standards would be made as demanded by traffic and as funds may become available. . . .

5. The benefits to be gained from the project from the American point of view are: [Six are listed]

6. Since the annual cost of operating Federal agencies in Alaska is about $7,000,000 in excess of revenues, the expenditure of an additional $3,000,000—spread over several years—for the purpose of development of the territory to a more nearly self-supporting basis is not unreasonable.

7. By the construction of about 200 miles of new road—in conjunction with about 1,000 miles of new construction in Canada—the territory would gain a physical connection with the vast continental system comprising hundreds of thousands of miles of road in United States, Canada, and Mexico. From the Alaskan or American standpoint, therefore, the advantages are obviously more than commensurate with the cost.

Here each section summarizes facts established by the examination report and on these facts bases conclusions arranged as a series of numbered points each coördinate with the others. Since a definite relationship exists between conclusions and recommendations, many reports follow the same plan and place the recommendations immediately after the conclusions. Indeed, the recommendation report, treated in the next chapter, is so closely related to the examination report that only the difference in emphasis, i.e., on recommendations rather than on conclusions, separates the two forms.

An interesting variation of the scheme of numbered conclusions is that found in the volumes of the New York *Regional Survey* under the heading "Facts and Findings." The following extract is from Vol. VII (New York, 1929):

(28)

SUNLIGHT AND DAYLIGHT FOR URBAN AREAS

The object of this study was to discover what is known as to the value of sunlight from the standpoint of health and how land and buildings may be arranged so as to supply suitable quantities of it.

The preponderance of evidence supplied by leading authorities pointed to the following conclusions with regard to a definite relationship between sunlight and health:

SUNLIGHT is a beneficial agent in the prevention and cure of rickets.

SUNLIGHT is a beneficial agent in the prevention and cure of certain common forms of tuberculosis.

SUNLIGHT is a beneficial agent in the prevention of certain other diseases through the destruction of harmful disease germs and through the general strengthening of the powers of resistance.

SUNLIGHT is a helpful agent in facilitating ventilation by causing gentle movements of the air due to the unequal heating by the sun of different sides of houses reached by it.

Consideration of how sunlight may be obtained raised the question as to how much is necessary or desirable.

There being insufficient knowledge at present for determining this accurately, it was decided to adopt as a reasonable minimum

standard such an amount of direct sunlight or its equivalent, for every living or sleeping room, as would be supplied by the sun shining for one-half hour at its maximum, or noon, intensity through windows of the prevailing dwelling-house size, facing south on the shortest day of the year. More than this minimum amount would be obtained, of course, throughout the rest of the year.

In order to meet this standard a better use of land than now prevails in much of the Region, and better planning of houses, are required. These involve, among other things, the direction in which streets are laid out and the orientation of houses on their lots, and are illustrated diagrammatically.

More than the sunlight standard may be obtained at noon in all windows looking toward the south, provided there is no obstruction which interferes.

In the morning and afternoon, however, the standard may be obtained only when streets do not vary from the north and south line more than 10 degrees. The largest amount of morning and afternoon sunlight is secured where streets run directly north and south.

Calculations to determine street widths, sizes of yards, and distances between houses indicate that by proper planning it is possible to secure more than the standard amount of sunlight without employing more gross land area than is now common practice in suburban residential districts of the Region.

Glossary of Terms Used in the Report.—It is often advisable to include in an examination report brief definitions of terms which are not generally familiar to the readers or words used in special senses. Much time can be saved in the presentation of data if the writer will condense his explanation of the terms he uses from time to time at an easily accessible place in his report. Sometimes this material is placed as a separate section, as in the *Report of the Engineering Board of Review, Hydrology of the Great Lakes: Part III, Appendix II.* Following are a few of the definitions facing Chapter I, page 1:

(29)

Discharge.—The quantity of water flowing through a given channel expressed in cubic feet per second.

Outflow.—The quantity of water flowing from a given lake through all of the channels leaving the lake; this equals the discharge of the outflowing river plus diversions.

Inflow.—The quantity of water flowing into a given lake through the outlet channels of the lake above.

Runoff.—The quantity of water flowing into a given lake from its tributary land area, exclusive of the flow received into the basin through the outlet channel of the lake above.

At other times the material is placed immediately in the context where it is to be used, as in Chapter XIII, "The Classification of the Shipworms of the Pacific Coast and Islands," in the *Final Report of the San Francisco Bay Marine Piling Committee* (San Francisco, 1927):

(30)

TERMINOLOGY USED IN DESCRIPTION

A brief explanation should be introduced at this point of the terms used in description of shells and pallets.

The *shell* is a reduced, sub-globular structure, gaping widely in front for the protrusion of the foot, and behind for the backward extension of the body. It is made up of two *valves* which articulate dorsally and ventrally by specialized knobs. Each valve is made up of three rather distinct lobes, an *anterior,* a *median,* and a *posterior.* The last named portion is frequently referred to as the *auricle,* a term which will be used throughout this discussion in order to simplify so far as possible a confusing terminology arising from the fact that the median lobe of the shell must be further subdivided into three areas, an *anterior median,* a *middle median,* and a *posterior median.* The areas designated by these terms are indicated in figure 68 [omitted].

The ridges of the anterior lobe are finely serrate, while those of the anterior median are coarsely denticulate; the ridges of these two areas are nearly at right angles to each other. At the backward margin of the anterior median area the denticles disappear, and the ridges curve sharply and continue across the middle median and posterior median areas and the auricle as ordinary lines of growth.

Writing Up Observations Made on a Field Trip.—In the preparation of an examination report it often becomes necessary to incorporate into the narrative accounts of observations

made on trips in the field. Such descriptions are characterized by specific words, carefully chosen to present the data upon which conclusions are to be based. References regarding time and place will usually be given at appropriate intervals in the narrative. A typical example, from "Sewage Disposal" (Part III, Appendix I), *Report of the Engineering Board of Review of the Sanitary District of Chicago* (Boston, 1925), follows:

(31)

On December 15, 1921, three of the members of the present Engineering Board of Review made an inspection trip upon portions of the canal system and Chicago River within the District. The following conditions were observed at that time:

In the North Branch the water was in bad condition, much grease and floating debris being noticeable between Kinzie Street and North Avenue. Above North Avenue the water appeared cleaner. Gassing was observed all along the North Branch, particularly in the turning basin just south of Diversey Avenue.

The water of the Main River and South Branch was in good condition, there being no evidence of septic action above the turning basin at Ashland Avenue. In the South Fork of the South Branch, however, the opposite condition prevailed. Constant gassing, together with the rising sludge from the bottom, was observed. The water in the West Arm was almost black and the surface was covered with a thick scum. In this Arm there was no flow except that due to the discharge from some very small sewers. . . .

United States Public Health Service Investigations of 1921 and 1922. During these investigations observations were made of the Des Plaines-Illinois River with respect to physical evidence of pollution.

At *Lockport* on September 2, 1921, the surface of the Main Drainage Canal appeared clean and free from floating material with the exception of a few dead minnows and small amounts of debris. A sewage odor was noticeable. On September 27, similar conditions were present with comparatively numerous dead minnows. On November 30, the stream had a grayish color but no odor. Small amounts of oily scum and debris were present. On January 29, 1922, the stream was nearly clean but with a grayish color. Traces of oily film were noticed but there was no odor. Samples of mud taken from the bottom were black with strong odor of putrefaction. Sewage fungi were abundant in the bottom sedi-

ment. On April 17, the stream was nearly clean, but contained moderate amounts of sewage fungi and shreds of paper. Mud collected was black, soft and with a tarry odor. A few sludge worms and a small amount of sewage fungi were present in this mud. On May 12, the stream had a grayish color and a slight odor. Large numbers of dead fish were observed floating on the surface of the stream. The sludge was soft and black with a moderate odor. . . .

Appendix and Index.—Two elements of the examination report—the appendix and the index—must still be considered.

The appendix, which is employed to supplement the text, is of more importance here than in any other type of report. It contains:

1. Documents and opinions which are too long for quotation elsewhere, such as laws, legal opinions, letters, and extracts from literature.
2. Specimens and charts presented as characteristic of materials and results, such as sample forms, maps, diagrams, photographs, and bulky materials of all kinds.
3. Data and statistics regarded as likely to interrupt the continuity of the text.
4. Problems and proofs considered too intricate to be understood without special study.

The index is similar to that in an information report.

Outline of a Typical Examination Report.—No matter what its field, the normal examination report will deal with most of the topics outlined below in an order that will not depart greatly from the one given. Since each report offers a special problem of presentation, no attempt has been made to plan the body of the text except in the most general way. As a rule, the results of office and field studies are so intermingled that they become integral, and samples, tests, calculations, and personal observations are worked into a unified, comprehensive picture.

I. Prefatory Material
   1. Title Page
   2. Table of Contents

3. Letter of Transmittal
4. Epitome, or summary of conclusions and recommendations
5. Occasionally, a Foreword

II. Text
1. Introduction
   A. Aim
   B. Scope
   C. Organization and Procedure
2. Historical Data, where these are pertinent
3, 4, 5, etc. Chapters developing the report, based on the results of office and field work and often including a preliminary examination

III. Supplementary Material
1. Appendices of the sort already mentioned
2. Index

Exercise: An Examination Report.—Prepare an examination report on one of the following topics. Employ as many as possible of the methods suggested in this chapter.

(1) A bridge; a poultry farm; a factory; a fruit farm; a machine shop; a mine; an orchard; a forest plantation; a sewage-disposal plant; a water-supply system; (2) a route for a highway; a trucking route; (3) a site for a camp; a site for a dam; a site for a driving park; a site for a moving picture theatre; a site for a reservoir; a site for a gasoline station; a site for a summer hotel; (4) a study of department stores; a study of camp equipments; a study of devices for fire prevention in factories; a study of one-way streets in different sections; a study of traffic regulations in small towns; a study of intramural athletics at your school; a study of student self-help work; a study of rooming and boarding facilities at your school; (5) a manufacturing plant; a power-distribution system; a research-laboratory layout; an airport.

CHAPTER 14

RECOMMENDATION REPORTS—OPERATION

Recommendation Reports Defined.—Examination reports may lead to definite conclusions from which obvious recommendations may develop. Unless, however, the writers are authorized to make such recommendations, they should not be included. Intrusion of this kind is always an impertinence. Often, however, information may be gathered for the express purpose of formulating plans for the future.

As is to be expected, reports which are devoted to such plans, although based on surveys and studies, differ in emphasis and in treatment from those which merely record factual information about the present. Consequently examination reports which stress recommendations may well be treated as a separate variety and defined as recommendation reports. Two kinds demand special consideration:

1. Operation Reports.—In this class fall reports recommending changes in procedure as applied to operation; that is, such matters as equipment, personnel, efficiency, marketing, distribution, location of plant, and the thousands of plans for improvement associated with modern commerce and industry. Many "business research" reports are of this type.

2. Construction Reports.—In this class fall reports concerned with projects rather than processes; that is, reports dealing with the construction of systems, plants, mechanisms, and machines. Many "engineering reports" are of this type.

Characteristics of the Two Kinds.—It is clear that the themes of the operation report are largely abstract and that those of the construction report are largely concrete. It is also clear that the treatment of the first is likely to be expository and that of the second descriptive. Although there is no

definite line of cleavage between the two, the operation report is mainly literal, and the construction report is mainly graphic in form. In the first instance, a writer explains and urges, by the citation of facts and figures, a course of action which he believes may be advantageous. In the second he describes and advocates, within the limits set by custom, a design which he feels is suited to conditions. The first is generally concerned with the problems of business and industry; the second, with those of engineering. Although the author of an operation report usually finds it necessary to consider construction, and although the author of a construction report is sometimes concerned with operation, each kind of report may be considered separately. This chapter is devoted to the operation report.

The Operation Report for an Expert.—When an operation report is to be submitted to a specialist in the field with which it deals, the data on which it is based—the facts accumulated in the preparation of an information or an examination report—appear as matters of course. The recommendations are merely the conclusions which spring from them. Under these circumstances, the premises on which they rest are of prime importance. However great the reputation of the writer, the reader, in all probability a superior of wider training and experience, will expect to test the accuracy of the investigation and the validity of the results. If he is to test them, he must know the procedure adopted. As prepared for a specialist, therefore, the operation report consists of an information or an examination report followed by a series of recommendations arranged as a summary.

The Operation Report for a Layman.—When an operation report is to be submitted to a layman, two distinct plans are possible. If the treatment can be understood without difficulty, the recommendations may follow the data on which they are based. This arrangement is usually found in the recommendation reports of the United States Army engineers. Since, however, the generalizations are naturally of more significance to the executives and boards for whom such reports are prepared than are the details, recommendations often appear at the

beginning, with the premises upon which they rest following in the text or even in appendices. The experience of a number of experts who have prepared reports for administrative officers in business corporations points to the conclusion that this form is nearly always advisable. Invariably executives, pressed for time, turn at once to the results themselves.

An example of the first kind of arrangement, that in which the recommendations follow, in logical order, the facts on which they depend, is to be found in *Smoke Abatement:*

(1)

Part VI

SUMMARY OF CONCLUSIONS WITH REFERENCE TO ATMOSPHERIC POLLUTION

601. RECOMMENDATIONS BASED UPON THE COMMITTEE'S STUDIES

SYNOPSIS: *The researches of the Committee have developed many matters which are of interest to those who are concerned with Chicago's problem of reducing atmospheric pollution. It is the purpose of this chapter to set forth the more important of these in the form of recommendations.*

601.01. CONCLUSIONS AND RECOMMENDATIONS.—The work of the Committee in all its phases has been an outgrowth of a desire on the part of the people of Chicago for a clearer and cleaner atmosphere. The essential facts, as revealed by the systematic researches of the Committee, concerning the extent and character of the more important agencies affecting atmospheric purity, the methods to be employed, and the difficulties to be met in any attempt to deal with them have been duly set forth. There may now be presented, as a concluding summary of the report, such recommendations as are likely to prove serviceable to the City in its subsequent efforts to improve the purity of its atmosphere. These recommendations are based upon the conviction that pure air is essential to the health and comfort of an urban population and that it is the imperative duty of the authorities of the city of Chicago to secure, through persistent and intelligent action, a clean atmosphere. The Committee's recommendations are as follows:

1. That there be created by the City a permanent Pure Air Commission, the membership of which shall be made up of persons possessing high technical qualifications.

2. That financial support be placed at the command of the Commission which shall be sufficient adequately to provide for the organization and development of investigations of a highly scientific character.

3. That the Commission be empowered to investigate all sources of air pollution and to determine, by experiment or otherwise, the most effective means for mitigating or eliminating such pollution, and that, so far as practicable, it be invested with power to enforce obedience to its decisions.

4. That no materials shall be employed in paving without the consent of the Commission, to the end that dust-creating pavement may be abolished.

5. That the paving and cleaning of alleys and other highways shall be subject to the supervision of the Commission.

6. That the Commission shall have power to require that the wrecking and erection of buildings shall proceed by methods which will protect the air from all unnecessary pollution.

7. That the Commission shall have the power to require roofs to be cleaned and other minor sources of air pollution to be abated.

8. That new installations of boiler and other furnaces be permitted only as licensed by the Commission, which shall have power, under reasonable rules, to determine the character of the installations.

9. That the Commission be charged with the duty of investigating present practice in the construction and operation of domestic furnaces with a view to so perfecting such practice that fuels now used may be burned without objectionable air pollution or to so changing the character of fuels as to accomplish the same result.

10. That the Commission be charged with the duty of investigating the construction and operation of metallurgical and high-pressure steam boiler furnaces, with a view to eliminating, so far as practicable, the air pollution for which such furnaces are responsible and that it formulate and enforce regulations under which such furnaces shall hereafter be constructed and operated.

11. That the Commission be charged with the duty of investigating the pollution of the air by railroad locomotives, by steamboats, and by other transportation agencies making use of movable engines, of devising methods of abating air pollution from these sources, and of enforcing such provisions for the suppression of air pollution as may be found necessary.

It is not the opinion of the Committee that radical action should be expected of the Pure Air Commission, or that action involving abandonment of the use of Illinois or Indiana coal is either advisable or practicable, or that action involving the general abandonment or rebuilding of existing boiler or heating plants, either stationary or portable, is advisable or practicable, or that the immediate or general electrification of railroads for the purpose of eliminating their part in air pollution is under present conditions advisable or practicable. It is deemed advisable, however, that all efforts to improve existing conditions shall be carried on with due regard to the responsibility of each of the fuel consuming services for its contribution to the pollution of the atmosphere and that such changes as may be determined upon may be gradually made with due regard to financial and mechanical difficulties.

The precise relations to be sustained by the proposed Pure Air Commission to existing municipal administrative individuals or bodies are assumed to be matters of detail, which have not been investigated by the Committee, and concerning which no opinion is expressed.

As indicated by this passage, it is customary to place before the recommendations a brief paragraph of introduction. A note of comment may also be added. In the extract above, the paragraph of introduction is interesting because the Committee explains in it the arrangement of the report. From this explanation, it is evident that the text falls into the two divisions already described—one consisting of facts, the other of conclusions "based" upon them. The final note is a kind of reservation. A comment of this character is specially valuable in fixing the importance of the suggestions made.

For emphasis and ease in reference, recommendations are usually paragraphed separately, each recommendation appearing as a single sentence. For the same reason, they are numbered consecutively and coördinated by parallelism.

It has already been pointed out that the more common arrangement is that in which the recommendations are placed at the beginning of the text. The scheme is well illustrated by the *Report of the Giant Power Survey Board, Commonwealth of Pennsylvania* (Harrisburg, 1925). An analysis of the report, seven pages in length, shows how the two elements—recommendations and the facts upon which they rest—are re-

lated. As the following extracts indicate, the conclusions and recommendations are based upon studies undertaken by authority of the Giant Power Survey Act of 1923 in order to secure the information called for by the Act and to prepare suitable recommendations on the basis of the data ascertained:

(2)

The Act "placed upon this Board two tasks: An outline survey of the facts and the recommendation of a policy that will best secure for the industries, railroads, farms, and homes of this Commonwealth an abundant and cheap supply of electric current." The Board concluded that "Public Power policy must, in Pennsylvania, be concerned chiefly with electric current produced by steam from the rich bituminous coal deposits in the western part of the state. . . ."

In the *Report* the Board notes five essentials to the generation of electricity by steam: "1. Adequate public agencies. 2. Mass production, which means 'abundant and cheap' production at the sources of raw material. 3. Mass transportation . . . 4. Adequate regulation . . . 5. Fair interchange of power . . ." On each of these conclusions, each of which is the subject of a special study in the appendix, the Board bases a series of recommendations, of which the following is an example:

"1. For the adequate public agencies we recommend:

(a) The creation of a permanent Giant Power Board . . .

(b) . . . enlargement of the powers of the Public Service Commission . . ."

Similarly, in the *Report on National Planning and Public Works . . . with Findings and Recommendations* (Washington, D. C., 1934), the "Recommendations," divided into five main heads and numerous subheads, occupy five pages at the beginning. In the *Government of the City of Rochester,* an "organization report" by the New York Bureau of Municipal Research, the first of the three main divisions is, "Suggestions Which Can Be Made Effective Without Change of the City Charter."

In all such cases, the details, however intricate or abstruse, are required for reference. If a client is not competent to analyze them, he may wish to submit them to others for verifi-

cation. Thus, the letter by Dr. Carpenter, on pages 14 and 15, in connection with the Hall of Records Power Plant, is an opinion regarding the accuracy of a study, extending over a year, which was substantiated not only by him but also by others. "As a result of my investigation," he remarks, "I have come to the conclusion that the data on which your calculations are based are conservative, reasonable, and correct." Under ordinary circumstances, then, every recommendation should be accompanied by the facts which are fundamental to it.

Unsubstantiated Recommendations.—In at least one instance, however, the recommendations only appear in a report. When a committee composed of specialists is selected from the members of a learned society to consider ways in which certain problems in the field may be solved, its report may often consist of little more than tabulated lists of suggestions. Such, indeed, is the "Report of the Subcommittee on Methods and Devices for Testing Aircraft Materials and Propellers," *Annual Report of the National Advisory Committee for Aeronautics* (Washington, D. C., 1934), reproduced below:

(3)

The subcommittee held one meeting during the past year, at which time the possible scope of the subcommittee's work was discussed. It was agreed that unless the work of the subcommittee was greatly restricted there was a wide field in which activities might extend. It was decided, therefore, to consider only those problems that are especially peculiar to aircraft structures. In this respect the needs as expressed by the members of the subcommittee may be summarized as follows:

(1) An accurate strain gage that can be used to study the strain distribution in aircraft structures. The strain gage should be of the distant-reading type, although a local-recording gage would be satisfactory in some cases.

(2) A brief but clear report that will explain the significance of the properties of materials with particular regard to acceptance testing. At present many tests are required in the acceptance of material that are of doubtful value.

(3) Standardization of certain tests for the time being with methods and devices now available. The drop-testing of landing gears is an example of this need.

(4) A method for disseminating information on methods and devices for testing aircraft materials and structures.

Consideration of the above needs resulted in the following reactions: That instrument makers be informed as regards (1); that a paper be prepared regarding (2); and that photographs and brief notes be prepared for circulation by the Committee in an effort to supply need (4). No action was taken regarding (3).

In line with (4) above, a report has been prepared in rough-draft form and circulated to members of the subcommittee. The purpose of this report is to make known the existence of strain gages now built by various manufacturers and to summarize in condensed form pertinent information regarding them.

Here the standing of the writers—with Henry J. E. Reid, of the National Advisory Committee for Aeronautics, as chairman, assisted by other representatives of the Committee, of the Army, the Navy, and the Bureau of Standards, and of private American industries—is sufficient guaranty of the soundness of their assumptions. Except in the most general manner, they cite no reasons for the suggestions which they offer. Seldom, however, is such independence possible. Almost invariably the operation report consists of the conclusions drawn from an information or examination report, which may precede or follow the recommendations.

Some Characteristic Problems.—Operation reports may deal with the affairs of a community, considered as a unit, or with those of a single industry. Except for actual construction, they may touch every matter affecting the conduct of these affairs. Some of these matters are discussed in the following sections.

Industrial Development of a Community.—Of duties thrust recently upon the engineer, one of the most interesting is a recommendation regarding the character of the industrial development suited to a particular community, whether a state or a municipality. In the past, business enterprises have often been established in a haphazard way without due consideration being given to economic conditions. As a result, progress in many districts has been lopsided, and transportation facilities

have been unnecessarily strained. To guard against undue specialization, with its attendant evils, and to determine whether an increase in manufacturing is justified by the facts, many states and cities now undertake periodic surveys which are useful to promoters and investors as well as to administrators. Without such studies, plans for municipal progress are likely to be ill-advised and unsuccessful.

In all investigations of this character, eight points must be considered:

1. Market	5. Capital
2. Competition	6. Labor
3. Material	7. Water
4. Transportation	8. Power

The way in which these points are related to conditions in a particular community appears in *Industrial Development in Kansas,* University of Kansas Bulletin 12 (1922), by P. F. Walker, Professor of Industrial Engineering and Dean of the School of Engineering, University of Kansas. In this report he considers three types of industry:

I. Industries that gravitate toward materials
II. Industries that gravitate toward markets
III. Industries that gravitate toward neither materials nor markets

I. Of industries that gravitate toward materials, he discusses, among others, the manufacture of pulp and paper goods, for which he finds Leavenworth well adapted. It is true that for a long time to come the market is bound to be purely local. Within a reasonable distance, however, there is certain to be an increasing demand for egg-case fillers and butter cartons as well as for heavier boards and boxes. All these articles can be manufactured profitably even though it is impossible to compete with the pulp mills of the North in other lines. Although certain materials would have to be imported, straw, which is basic, can be drawn from the fertile counties in the neighborhood. Transportation facilities are excellent. In the light of experience, also, there seems to be no reason for doubting that the necessary labor can be secured. Regarding

capital, the outlook is not so hopeful. As Kansas is primarily an agricultural state, its banks have not been accustomed to industrial credits on an extensive scale. Unless a mill appeals to civic pride and interest, its directors are not likely to secure the accommodation which the business man in the East expects as a matter of course. To succeed, a company would undoubtedly need a large reserve. Apart from this drawback, since water and fuel are both available, there is apparently no reason why the manufacture of paper goods at Leavenworth should not be a profitable undertaking.

II. Since Kansas, as already emphasized, is an agricultural community, it is an important market for agricultural implements of all kinds. Of industries that gravitate toward markets, it might therefore be supposed that the manufacture of these implements would be among the first to be introduced. Nothing can be further from the facts. There is practically no manufacturing of this character in Kansas now, and there is not likely to be any in the immediate future. In the first place, the industry, already localized in the North, is controlled by several powerful corporations. In the second place, production has far outstripped demand in the United States. In the third place, the export trade, owing to the slump in most currencies, has virtually collapsed. Since Germany can now sell implements in South America at less than the cost of manufacture in Cleveland or Chicago, there is little hope of countering the attempt which she is making to reëstablish her international position. In view of the fact that these conditions are likely to continue indefinitely, the only possible development in Kansas is the establishment of assembling plants that may gradually extend their functions to include the manufacture of specialties. In this case, competition is the decisive factor.

III. In addition to enterprises that gravitate toward materials or markets, there are various groups such as the textile industries that are usually located at a distance from both materials and markets and that are dependent primarily upon the initiative and energy of their founders. The manufacture of woolen goods is such an industry. In this instance, a local market is of no significance; and though the trade is highly

organized, the experience of a number of independent factories shows that, under proper conditions, competition can be met successfully. The character of the material, however, is a serious obstacle. Since Kansas wool is of low grade, only coarse varieties of knitted goods could be produced. Business would therefore be limited from the start. Moreover, though railroad connections are excellent, though capital, which is being stimulated by the growth of cotton factories, would probably be available; though labor also might be obtained; and though water and fuel are both at hand, there is one permanent drawback. Humidity is essential. In a dry atmosphere like that of Kansas, the fibres would undoubtedly become hard and brittle. Consequently, special treatment, such as "washing," would be necessary. These limitations indicate that no extensive scheme of woolen manufacture is justified at the present moment.

The procedure followed in the case of a municipality appears in the *Industrial Survey of Portsmouth, Virginia* (Blacksburg, Virginia, 1931), prepared by the Engineering Extension Division of Virginia Polytechnic Institute.

The report covers the following topics:

(4)

1. Present Industrial Development

   [This chapter also discusses available industrial sites and industries desired.]

2. Primary Economic Factors in Plant Location

   [This chapter deals with the eight points mentioned above as they apply to Portsmouth with the exception of capital and competition.] The headnote to the chapter indicates the items treated:

   Before locating a manufacturing concern it is necessary to study those factors which principally govern the successful operation of industry. This chapter undertakes to discuss the elemental considerations of successful industrial development as they apply to industry in general. In some types of industry the raw materials are the principal factors; in others, the labor and power situation. Some operations are greatly affected by cli-

mate while still others are principally dependent upon expeditious transportation. Although these factors do not apply alike to all industry, the general considerations are the same. The essential matters are natural resources, produced resources, labor, power, transportation, markets, public utilities, and climate.

3. Secondary Factors for Industrial Development
   [This chapter presents facts concerning the city government, services of safety and health, taxes, public debt, banking facilities, and housing.]
4. Civic Refinements
   [This chapter takes up community life and activities and facilities from churches and schools to local transportation and newspapers.]
5. General Business Data

Appendices provide general historical information about the community and industrial statistics for Virginia.

Exercise: Industrial Development of a Community.—Prepare a report upon the industrial development that seems to be justified by conditions in a town or village. Select, if possible, a municipality which, for some reason, has hopes of expansion in the future.

Civic Development of a Community.—Public and private organizations alike sponsor surveys of the kind described in the last section. Although the results of these surveys are intended to provide ammunition for campaigns of promotion, they are also employed as guides for civic undertakings. Indeed, the recent progress of city planning has resulted in the establishment not only of college courses in the field but also of special firms of architects and engineers who will undertake the survey of a city and prepare a comprehensive plan for the future. Such a plan will anticipate growth and suggest an economical scheme for development based not only on past tendencies and present conditions but also on future possibilities.

A study of a number of such municipal planning reports shows that all of them treat with more or less completeness topics which may be characterized as

1. Economic, or
2. Social, or
3. Aesthetic

In their attractive report, *A Comprehensive Plan for University City, Missouri* (St. Louis, 1931), the authors, Harland Bartholomew and Associates, devote four pages to a brief consideration of the principles of city planning. They point out that:

(5)

City Planning is that phase of municipal activity which analyzes the character and probable extent of the city's growth, suggests certain physical readjustments, and provides for the coördination of all future improvements. Under proper and sympathetic administrative agencies it makes possible the economical development of an orderly, well-arranged city which provides good living conditions for all its citizens, which is everywhere wholesome and attractive in appearance, and which is free from physical defects that hamper commercial and industrial activity.

It is a well recognized fact that modern cities are lacking in unity of design, do not easily promote the expansion of commerce and industry, and have numerous residential districts of doubtful value. The past few years have produced a noteworthy public realization of the deficiencies and mistakes of unbridled city growth. There are few cities which are not now engaged in attempting to correct evils resulting from neglect.

City planning is essentially concerned with the *physical* development of cities. It has nothing to do with political interests or factional differences. The city plan is a beneficial instrument affecting the lives of all city dwellers as long as the city endures.

The divisions which properly constitute the city plan are six in number:

(1) Streets
(2) Transit
(3) Transportation (rail, water, and air)
(4) Public Recreation
(5) Zoning
(6) Civic Art

These are the physical elements which, when properly planned and correlated, make possible the creation of an attractive and orderly working organism out of the heterogeneous mass we now call the city.

In the development of a city plan by which the growth of a city may be controlled over a period of years, we are confronted with the application of these six principles in

(a) Areas now wholly or partly developed with streets, buildings, and customary improvements; and
(b) Areas as yet undeveloped and unimproved.

The most far-reaching study in connection with the civic development of a community is that initiated by the Russell Sage Foundation, the *Regional Survey of New York and Its Environs* (New York, 1927-1929), now published in ten large volumes, covering the following topics:

Volume I. Major Economic Factors in Metropolitan Growth and Arrangement
Volume IA. Chemical, Metal, Wood, Tobacco, and Printing Industries . . .
Volume IB. Food, Clothing and Textile Industries, Wholesale Markets, and Retail Shopping and Financial Districts . . .
Volume II. Population, Land Values, and Government
Volume III. Highway Traffic
Volume IV. Transit and Transportation—Including a Study of Port and Industrial Areas
Volume V. Public Recreation
Volume VI. Buildings: Their Uses and Spaces About Them —Including Reports on Zoning, Housing and Economics of High Buildings
Volume VII. Neighborhood and Community Planning. Three Monographs on the Subjects of: The Neighborhood Unit; Sunlight and Daylight for Urban Areas; and Problems of Planning Unbuilt Areas
Volume VIII. Physical Conditions and Public Services

In addition, the data and conclusions of this momentous survey became the bases for two impressive volumes: *A Regional Plan for New York City*, Volume I, "The Graphic Regional Plan" (New York, 1929), and Volume II, "The Building of the City" (New York, 1931), which is a com-

plete recommendation report for the development of the metropolis. Although the report is on too vast a scale to be useful as a guide, no writer of reports on city-planning can afford to neglect it for its accuracy, for its completeness, and especially for its eloquent and masterly style.

Considerations of space forbid quotations from the report; but as an illustration of effective writing, every writer of reports may well read the sections entitled, "The Plan as a Practical Ideal," and "Education and the Civic Spirit," in Chapter IV, Volume I; and, in Volume II, Chapters I and XVII: "City Planning in a Democracy," an informing survey of previous efforts in America, and "The End in the Beginning," an essay on the meaning and future of the city, which is worthy of a place as literature.

Exercise: Civic Development of a Community.—Prepare a report on some phase of civic development advisable in a country village or a city ward. Consider, for instance, a hamlet composed largely of retired farmers or a section inhabited mostly by unskilled laborers. Apply, where possible, one of the procedures which has been outlined by the Foundation.

Location of a Proposed Industry.—For a variety of reasons industries are constantly building new plants, branches, warehouses, and retail establishments and abandoning old plants and relocating them in more favorable surroundings. Although boards of trade, railroads, and even semi-public agencies sometimes sponsor the necessary investigations, such undertakings are usually based upon surveys by experts and specialists, employed privately at considerable expense to recommend a satisfactory site. These studies deal with problems of market, competition, material, transportation, capital, labor, water, power, costs, and returns; in fact, with all aspects of the situation needed by executives in making a decision.

Typical of such location reports is one prepared by the Stone and Webster Engineering Corporation [1] for a large manufacturer desiring to build a plant in the Middle West. By

[1] Typewritten report prepared in 1928. The quoted material is reproduced through the courtesy of Major John Coffee Hays, Vice-President of the Stone and Webster Engineering Corporation.

the manufacturer's wishes, the territory was limited to an area within a radius of fifty miles of Chicago. The report runs thus:

(6)

From a study of the general requirements of Blank Company it appeared that an ideal site would require level land reasonably priced, low construction costs and taxes, adequate quantities of cold water, a plentiful supply of intelligent and contented labor, service by two or more railroads, low freight rates and prompt shipping movements, moderate summer temperatures, unobjectionable neighboring industries, and minimum operating costs. In order to consider in detail the many available locations with respect to these requirements, we established factors shown in Table 1. [See page 349.]

Possible Sites

As a result of inspecting and investigating over one hundred properties, we selected for further study one site at each of seven representative locations as follows: [Locations omitted.]

Plate II [omitted] indicates the general location of each of the seven sites. Each site selected was considered the best in its locality but was not the only land available. As the proposed plant could be built and operated successfully at any of these sites, a comparative analysis was made to evaluate so far as possible their relative economic advantages or disadvantages.

As indicated by the table of contents reproduced on page 348, the report, which covered both tangible and intangible factors, definitely recommended the site which presented the most favorable aspects for all of these factors.

The table of "Factors Considered in the Selection of a Site" is evidence of the care with which such a survey takes into consideration every detail affecting a decision. It may well serve as a guide in the preparation of location surveys. This table appears on page 349.

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TABLE I

FACTORS CONSIDERED IN THE SELECTION OF A SITE

LAND	**TRANSPORTATION**
Present value	Rail
Future value	Water
Topography	Highway
Subsoil conditions	**ATMOSPHERIC CONDITIONS**
Existing improvements or obstructions	Temperature
Improvements necessary	Humidity
	Smoke, dirt, odors
TAXES	**CONSTRUCTION COSTS**
Local taxes	Building codes
Corporation taxes	Labor rates
Trend of taxes	Foundations
COOLING WATER	**WASTE DISPOSAL**
Source and quantity	Water
Temperature	Sludge
Analysis	
LABOR	**SERVICES**
Supply	Electric
Rates	Steam
Efficiency	Gas
Turnover	Sewers
Troubles	**OTHER CONSIDERATIONS**
Nationality	Banking facilities
Housing	Postal facilities
Transportation	Telegraph facilities
DISTRIBUTION	Advertising value
Freight rates	Accessibility from . . .
Cost of warehousing in . . .	Provisions for changes in manufacturing process
Time required for shipments	

Exercise: Location of a Proposed Industry.—Prepare a report upon the establishment of a small business, especially one which is seasonal in character. The following subjects can be treated fully in a short time:

An advertising agency; an apple orchard; an automobile service station on a state highway; a bathhouse on a lake; a canoe livery on a river flowing through a city; a checking ground for automobiles near a baseball park; a chicken farm; a cigar store; a fish hatchery; a gasoline station at a crossroad; a local telegraph office; a limestone

quarry; a messenger service in a city; a neighborhood drug store; an outdoor skating rink; a refreshment booth at an amusement park; a restaurant near a college campus; a spruce plantation; a toboggan slide; a toll bridge; a truck farm.

Valuation of an Established Industry.—As business expands there is a constant demand for new capital, which is usually secured through some accepted financial channel such as stocks or bonds. Financiers, however, no longer rely upon their own judgment in underwriting such issues; they invariably turn to others for advice. Indeed, investment houses which supply capital now call increasingly on the engineer, the economist, and the statistician to aid them in reaching a decision. A recommendation report prepared by these experts deals with factors such as (a) location; (b) nature of field in regard to markets, competition, material, transportation, labor, power, etc.; (c) plant, both in its physical aspects of layout of machinery, etc., and in its administrative aspects; and finally (d) result of operation, as indicated by a balance sheet and income-sheet analysis.

One investment house [2] uses the following outline in its valuation reports on industrial companies (to conserve space, only the sectional headings are reproduced below):

A. History of firm
B. Nature of industry
C. Factors influencing localization of industry
D. Elements of cost, i.e., labor, raw materials, transportation, etc.
E. Marketing the product
F. Demand for product
G. Possible government interference or legislation
H. Management
I. Labor problems
J. Balance sheet analysis (in detail)
K. Income account (In detail)
L. Financial policies [3]

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2 Quoted in E. E. Lincoln's *Applied Business Finance* (Chicago, 1923), pp. 220-221. Reprinted by permission of Mr. Lincoln.

3 A typical valuation report is available in Charles W. Gerstenberg's *Materials of Corporation Finance* (New York, 1915), pp. 783-898. This "Report on the Investigation of the Chicago Telephone Company," prepared by Edward W. Bemis, is a model both in fact and in form.

It is interesting to compare with this outline an actual valuation report, *A Report on Property and Business* (New York, 1936), prepared by the Stone and Webster Engineering Corporation for a banking syndicate in connection with the sale of securities. The following paragraphs [4] are quoted from the letter of transmittal:

(7a)

As shown by the registrant's audited balance sheet, the aggregate net amount at which the properties are carried is $138,365,948 and we are of the opinion that this is a reasonable figure for the property as a whole operated as a coördinated going concern. In arriving at this opinion we have accepted without prejudice the appraisal of.................. on the coal properties, which are carried on the books at $28,016,995.

In building up the details by companies, our appraisals in individual cases are either higher or lower than shown on the books, although our total is somewhat greater. On the utility property, where value is the principal controlling factor in the regulation of rates, our figures indicated a cost to reproduce new, less depreciation, greater than the net value shown on the books. In the case of the.........coke plant we made a detailed appraisal some years ago and by bringing this up to date by adding subsequent expenditures and adjusting for price level, we arrived at a figure considerably below that carried on the books. In the case of the...... ....and..........coke plants we merely trended the actual costs, and we are of the opinion that similar plants could be built today for materially less. The business of these coke plants is primarily competitive but due to the fact that they supply gas to regulated utilities, their operations and values may be scrutinized by regulatory bodies who have jurisdiction over the utility properties. The design and construction of these three coke oven plants represent the best practice and their operating efficiencies are high, and because of the nature of the business we see no opportunity for a competitor to build a plant at any of these locations and successfully compete. The ships were appraised on a yardstick tonnage basis of cost to reproduce new less depreciation. The blast furnace was considered on the basis of original cost modified as to price trends and observed depreciation. The figure at which

[4] Reproduced through the courtesy of Major John Coffee Hays, Vice-President of the Stone and Webster Engineering Corporation. All names are omitted because of the confidential nature of the report.

it is carried on the books appears to us as reasonable if one bears in mind that the future commercial operation of this piece of property is problematical.

It is clear, therefore, that the property to be included under the mortgage may be considered to have a fair aggregate value, under the circumstances under which it is proposed to be used, in excess of the book value. The sum total, however, of the component parts of the coördinated whole if separated might not have such value, and the salvage value of any uneconomic unit would be small. Certainly the earning power in case of segregation might be substantially affected so that in fact one of the principal considerations of the bondholder should be to look beyond the book value to what the coördinated units may reasonably be expected to earn under the conditions which exist and which it is not unreasonable to believe may continue to exist.

Due to the fact that the net earnings of certain subsidiaries for the past three years show a declining trend it is important to consider the reasons involved. During the last few years general business throughout the country has been in a rather chaotic condition and the future appears to hold promise of continuing changes in American industry, so that there are many unpredictable factors such as devaluation of the dollar, taxes, tariff, changes in rate structures by regulatory bodies, the easing of competitive situations due to rising anthracite costs brought about by possible wage increases, extension of markets for gas outside of the.......... area, and matters of a similar nature which may affect either adversely or favorably the various operations and units of this property. While we do not believe that any responsible person would venture an opinion as to the future general business trends, it is proper to discuss the causes contributing to the immediate past trends and what may be the limitations or probabilities viewed from a strictly present day standpoint.

In the first place the project as a whole is unique and well conceived, having as a nucleus a basic commodity in the necessity class and set up to receive the advantages incident to its production, transportation, conversion, and distribution in a way that makes it predominantly self-contained and at the same time furnishes certain diversification. The coal mining operations and coal sales are in direct competition with similar operations in that industry and according to record have shown an ability to earn when many others have failed. There seems no reason to believe that these relative conditions should change.

The steamship activities, because of the good use factor assured by associated subsidiaries, have demonstrated a capacity to earn at the same or less rates than charged by competitors and there seems no reason why this should not continue.

The utility properties are seasoned and well established and are under the jurisdiction of a commission whose rulings have generally been considered to be reasonable. The present rates yield a return which we believe is substantially less than could be demonstrated to be a reasonable return on fair value. . . .

We did not attempt a detailed study of the system personnel but our observation of those with whom we came in contact, augmented by our previous acquaintance with some individuals in important positions, and by the operating results as discussed in this report, serve as a basis for our favorable impression of the Management and the general fitness of the members of the organization for the positions they fill.

To summarize, the earnings of this group are dependent to a large extent upon the coördinated operation of the group as an entirety and the validity of the intercompany and other major contracts in effect. The earnings from certain of the properties are affected by the regulation of rates by public bodies and the earnings from other properties are affected by unregulated competition in the open markets. Our analysis of the earnings of the individual units of the system indicates that the variations in the last three years are due to various circumstances, some of which are continuing and some non-recurring. We have pointed out where certain earnings appear to be subject to further reduction, but it is our opinion that the falling off of earnings in the period does not, and should not be interpreted to, represent a definite trend. From a present day viewpoint, we believe that it is reasonable to expect that the coördinated properties can earn at a rate which will yield a substantial margin over and above the amounts required for servicing the proposed bond issue referred to, after allowing for reasonable adjustments which may be expected in the various phases of the coördinated operations.

The report, after a general introduction devoted to the activities of the company, is divided into three main sections:

1. Description of Property
2. Appraisal of Property
3. Factors Affecting Business

The sections dealing with the blast furnace will serve as illustrations of the style and technique:

(7b)

(From "Description of Property")

The............Companies also own a blast furnace located on the same plot of land occupied by its......coke oven plant, of which approximately 65 acres are set aside for furnace operations.

Erection of this blast furnace was completed in 1926. It consists of a stack 87 ft. high with a hearth diameter of 17 ft.; three stoves, with the necessary dust collecting and gas washing systems, a cast house with space for three iron runners and one slag trough, a ladle house with a two-strand pig casting machine, and an ore dock with unloaders, stocking and reclaiming bridge, stock bins and skip hoist. The capacity of this furnace is estimated at approximately 190,000 net tons of merchant pig annually.

The boiler and electric generating plant attached to the Blast Furnace Plant consists of 7—800 h.p. boilers and 2—937 KVA turbo-generators and has a capacity exceeding the requirements of the blast furnace proper and its accessories, and is in use for supplying steam and electric power to the.........coke oven plant and the gas production plant of the.........Gas Company. Five of the boilers are equipped with stokers for burning coke breeze and two are equipped with oil burners, while three are also arranged for burning blast furnace gas.

The blast furnace was blown in during September 1926 and was kept in operation until August 1931, when it was shut down because adverse market conditions did not permit of its profitable operation. The furnace is now in the process of being relined and it is contemplated that it will again be put into operation in the first half of 1936.

(From "Appraisal")

The blast furnace property of The...............Companies at.........was appraised at $5,077,000 by determining its initial construction cost and subsequent additions and adjusting these costs to December 31, 1935 price level. Depreciation was estimated from our observation of the physical condition of the property.

(*From "Factors Affecting Business"*)

As stated previously, the furnace is capable of producing 190,000 net tons of merchant pig iron annually and in the course of this activity would use approximately 175,000 net tons of coke. Since this represents approximately 17% of the average annual production of coke by the........coke plant the operation of the blast furnace would tend to increase largely the amount of coal produced and tonnage carried by subsidiaries of.................. .... It is therefore obvious that the net income from furnace operations by itself does not disclose the total benefits to be derived by the system from the operation of the furnace.

The plant was undoubtedly originally conceived and erected with these factors in mind but the principal factor which probably influenced the decision to erect a blast furnace in 1926 was the assumption that the output of the furnace would sell at $27 or $28 per ton of merchant pig. This expectation was never realized and the present published........base price for pig is around $20 a ton. Aside from this relatively low price of American pig iron, the market on the eastern seaboard which is served by the........ blast furnace, is affected by competition, severe though limited in volume, through the importation of Netherlands and East India pig iron; approximately 100,000 tons of foreign pig iron being delivered annually to the eastern seaboard from Maine to Baltimore. Netherlands pig can be purchased here at approximately $19 per ton while India pig has been quoted recently at approximately $13 per ton. Taking these factors into consideration, future profitable operation of the........blast furnace is rather doubtful unless higher tariffs impose a barrier between foreign and domestic production or improvement in general business conditions result in a large increase in the local demand for pig iron.

A favorable aspect is to be found in the fact that the establishment of a blast furnace made it possible for the................. users to purchase pig iron at a saving in freight rates compared to that from other furnaces serving this market. The construction of the furnace was based on an existing freight differential of $2.31 against competing American furnaces. Shortly after the furnace started, Buffalo obtained a reduction in rate of approximately $1 per ton and somewhat later a combined rail and water rate was published which gave the Alabama furnaces an entry into New Jersey and New England so that some, though not all, of the expected freight advantage has been lost. Under the circumstances

there is reason to believe that................users will always desire to take at least a part of their pig iron requirements from the ....blast furnace.

At the present time the Company is relining the furnace and it is contemplated that it will be blown in again in the first half of the current year. The primary purpose of this operation is to convert some $580,000 of ore inventory, which is not salable, into pig iron and this activity will undoubtedly result in cash return not otherwise realizable. The estimates which have been prepared on this operation include figures covering inventory values of raw materials, cash requirements for additional materials to be bought, cost of labor and of reconditioning the furnace, but do not include depreciation or fixed charges on the furnace which the Company would have to carry in any event. While the starting up of the furnace at this time to work up the available inventory appears to be entirely justified, the continued operation after this purpose has been accomplished, which is estimated to take about six months, is problematical and depends entirely on future market conditions as to price and volume of demand.

Exercise: Valuation of an Industry.—Prepare a report on the value of one of the small businesses listed on pages 349-350 which is to be found in the neighborhood.

Status of an Industry.—In addition to the type of report which has just been described, there is another type which is closely connected with it. Many large business and industrial firms such as Sears, Roebuck and Company and General Motors Corporation and manufacturers' associations such as The Textile Institute and The Iron and Steel Institute take stock periodically of the business or industry as a whole. Progress may depend, to some extent, upon familiarity with conditions which are duplicated in a large number of stores or plants. Such reports, usually prepared privately by experts, may often lead to far-reaching changes in policy and technique. Among recently published investigations, *The Passenger Car Industry: Report of a Survey* (Philadelphia, 1932), by Charles Coolidge Parlin, Manager, and Fred Bremier, Assistant, of the Commercial Research Division, Curtis Publishing Company, may be taken as typical. In the foreword, reprinted on page 41, the authors indicate that the study was made "to ascertain

fundamental conditions and enduring tendencies." Although it is not essentially a recommendation report, it does present conclusions and data upon which manufacturers may shape the policies of their companies.

Similarly W. R. Ingalls, in his *World Survey of the Zinc Industry* (New York, 1931), a report prepared for the Mining and Metallurgical Society of America, presents a comprehensive summary of the zinc industry in 1930. His conclusions and recommendations, several of which are given below, illustrate the purpose and value of this type of report:

(8)

4. The developed resources of zinc ore and the known accumulations of zinkiferous material are of such magnitude that the market could be flooded with zinc if exploitation should be unwisely intensified. . . .

6. The zinc industry of the United States has become a self-contained economy by virtue of tariff protection. That of the rest of the world is substantially free, but political interferences may be introduced.

7. The tendency to establish new production is enhanced by aspirations to develop separate and adequate national supplies with the view of promoting national industries and insuring means for defense.

8. Such national tendencies increase the hazards in developing new production in parts of the world where spelter must be exported.

9. Intemperate production from the great mines for the purpose of shortening the liquidation of their resources may so depress the price for spelter as to defeat the purpose.

10. Likewise capital invested in new metallurgical plant, even if it be of superior effectiveness, may fail to realize an adequate return, while extinguishing the value of previous plants. . . .

13. A surplus of metallurgical capacity exists in the United States. Elsewhere, only reasonably. Improvement of existing capacity with the objective of increasing the percentage of zinc extraction will *ipso facto* tend to augment spelter production.[5]

[5] Reprinted by permission of the author.

CHAPTER 15

RECOMMENDATION REPORTS—OPERATION (CONTINUED)

Special Studies.—In connection with the location, valuation, or operation of an industry, special studies covering all the points mentioned are constantly required. Investigations like these may deal, for instance, with market, material, or transportation; with the physical or administrative aspects of a plant, or with the financial conditions. Because reports on these subjects follow well-recognized grooves, they will be considered in detail.

Market.—It is hardly necessary to emphasize the importance of a market in connection with any business enterprise. So important is it that special studies are constantly being made in order to determine the advisability of establishing, maintaining, or extending particular industries. Many firms are accustomed to adjust their production to the demand through surveys of this character made from season to season. In the past these surveys have usually been entrusted to assistants trained primarily as salesmen. Today they are often made by experts, whose specialized knowledge has proved useful in sales departments.

A large number of firms are now engaged in the business of conducting market research, and hundreds of private surveys are made by them each year. As indicated on page 199, the Bureau of Domestic and Foreign Commerce publishes annually a bibliography and a list of market research agencies in the United States in its *Market Researches Sources,* of which the 1936 issue is Bulletin 55 of the Domestic Commerce Series. The Bureau itself has conducted many such market studies, most of which may be secured from the Department of Commerce upon payment of a small sum. Because of the importance of this form of report, it is worthy of consideration.

Sales and Market Reports.—Increasingly business organizations are turning to the newly developed field of market research for answers to problems connected with the marketing of their products. The purposes of market research studies may be summarized as follows:

1. To find out what the customer wants and why, who he is, and where he lives, and how many potential customers are available.
2. To gather data on which to base the design of products in line with the customer's wants, to describe products in the language he uses in expressing his wants, and to direct merchandising tactics to fit his current buying habits.

The tendencies of modern industry toward large-scale and far-flung operations have resulted in a wide separation between producer and consumer. Thus, as Mr. Alfred P. Sloan expressed it in a recent letter to stockholders in the General Motors Corporation, ". . . it becomes increasingly important that we provide the means for keeping our products and our policies sensitively attuned . . . and . . . I am confident that a more intimate, detailed and systematic knowledge of the consumer's desires will afford the Corporation a sound and progressive basis upon which to meet the new conditions. . . ." In recognition of the needs of business, numerous university courses have been established, textbooks have been published, and periodicals in market and sales research have been founded. Moreover, hundreds of concerns now maintain staffs to conduct consumer, sales, marketing, and advertising research.[1]

The field is so vast that no attempt will be made in this book to cover it adequately. The principal types of market research studies have, however, been outlined clearly in a recent survey, *Sales and Market Research for the Eastman Kodak Company,*

[1] A brief manual, *Simplified Market Research* (Philadelphia, 1935), by Frank R. Coutant and J. Russell Doubman, offers a simple yet comprehensive discussion of methods and fundamentals. It covers such topics as the field of research, selection and limitation of the problem, sources for material and how to use them, how to secure information by questionnaire and interview, how to classify and analyze the material, and how to present it.

made by the Statistical Department of that Company.[2] The outline below is especially illuminating:

(9)

General Scope of Market Research

A. - Distribution

1. Sales Analysis
    - Divisional and territorial analysis:
        - Product sales
        - Quotas
        - Salesmen's accomplishments, calls, demonstrations
        - Purchasing power
        - Distributing facilities
        - Profitable accounts, etc.

2. Advertising Research
    - What types of advertising are most effective?
    - Analysis of media circulation compared with sales.
    - Suitability of media for various products.

3. Distribution
    - Relative effectiveness of various channels of distribution.
    - Price policies, discount schemes, etc.
    - Divisional and territorial comparisons of adequacy.

4. Service
    - Standards of service to consumer and dealer determined through field research.
    - Dealer service to customers.

5. Aid in determining selling policies as revealed through contacts with dealers and consumers and synchronizing merchandising tactics with current buying habits.

6. Competition
    - Extend field contacts and investigations to obtain current data on competition.

2 This report, in typescript, has been made available to the authors through the courtesy of the Eastman Kodak Company.

B. Studies Relating to Product

1. What do consumers want in a product?
   - Style
   - Price
   - Quality and durability
   - Size, etc.

2. How do consumers use Product?
   - Frequency
   - Method
   - Purpose
   - New uses

3. Establish contacts with selected customers, dealers, merchandise buyers, to determine trends in demands for style, price, quality, etc.

To this list may be added such general items regarding the market as

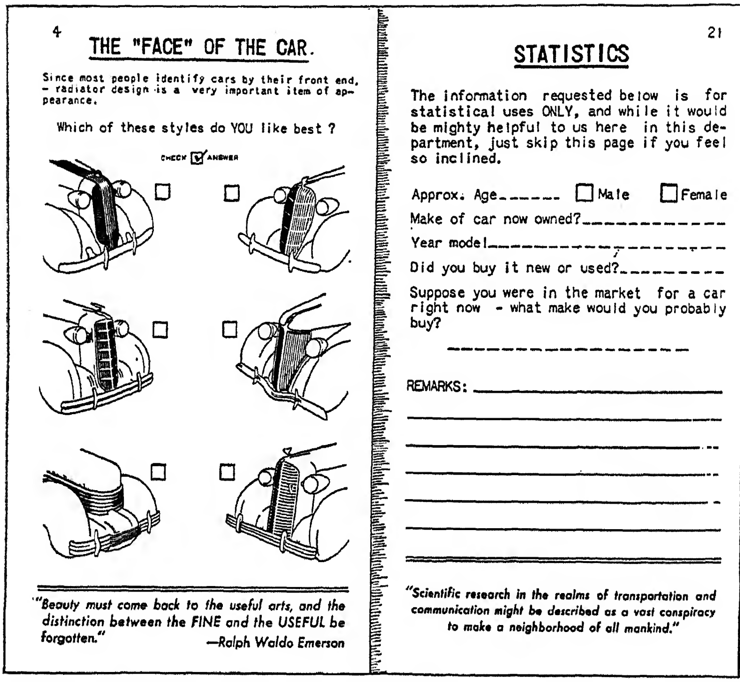
A. Population studies, showing number, density, rates of growth and classification by income, age, nationality, sex, etc. . . . to indicate the potential market.

B. Economic studies, showing incomes, buying power, buying habits, dealer buying and financial, general business conditions in relation to market, etc.

The preparation of market research reports offers no special difficulties or complicated problems. The research is usually conducted by means of questionnaires, of which the recent questionnaires to owners of General Motors automobiles are excellent examples. Specimen pages from one of these questionnaires are shown on the following page.

Research is also conducted by means of interviews by trained interviewers, or by a combination of questionnaires and interviews, a method which is now in favor with market research organizations such as Daniel Starch, the Psychological

Corporation, the Dartnell Corporation, and others. Although skill is required in selecting samples, in preparing questionnaires, and in conducting interviews in such a way as to avoid



4

THE "FACE" OF THE CAR.

Since most people identify cars by their front end, - radiator design is a very important item of appearance.

Which of these styles do YOU like best ?

CHECK ☑ ANSWER

"Beauty must come back to the useful arts, and the distinction between the FINE and the USEFUL be forgotten."
—Ralph Waldo Emerson

21

STATISTICS

The information requested below is for statistical uses ONLY, and while it would be mighty helpful to us here in this department, just skip this page if you feel so inclined.

Approx. Age______ ☐ Male ☐ Female

Make of car now owned?____________

Year model________________

Did you buy it new or used?_________

Suppose you were in the market for a car right now - what make would you probably buy?

____

REMARKS: ____________________

"Scientific research in the realms of transportation and communication might be described as a vast conspiracy to make a neighborhood of all mankind."

Specimen Pages from a Questionnaire Prepared by General Motors Research Staff.

Note attractive layout and ease with which answers may be entered.

stereotyped responses, the compilation of results is a routine statistical task; and the writing itself demands little more than skill in dealing with the material simply and vividly in non-technical language.[3]

[3] Ideals for reports in market research are stated succinctly in the instructions to investigators prepared by the Meredith Publishing Company and quoted by Coutant and Doubman, *Simplified Market Research*, p. 14.

(10)

1. The truth is the end sought. Error is not to be disguised, falsehood tolerated, nor preconceptions favored.

2. Comparisons can be made only between things, conditions, times, and places having common qualities.

3. In interpretation, facts must always be referred to conditions which can produce them.

4. Interpretation should extend to an explanation of the past and a forecast of the future.

5. Distinctions should be made between established facts and opinions.

6. Distinction should be made between long- and short-time conditions and consequences, between transitory skirmishes and general tendencies.

7. Distinction should be made between the result of a single cause and a combination of causes.

8. Distinction should be made between drawing a particular deduction and giving it general application.

9. Similarities and differences should be appraised in the light of particular application. Similarities which are seemingly complete and differences which are fundamental for one purpose may be ignored for others.

10. The details of interpretation should conform to the nature of the problem and the capacity of those interested.

As a rule, such reports present the most important findings, conclusions, and recommendations on a single sheet either in the letter of transmittal or immediately succeeding it. The results are grouped, topic by topic, in tabular form with appropriate comment. The questionnaire or an outline of the interview and a discussion of the character of the sample are invariably included.

Representative excerpts from *Camera Ownership and Use,* a study [4] prepared for the Eastman Kodak Company (March, 1936), will illustrate the technique:

[4] A report in typescript reproduced through the courtesy of the Eastman Kodak Company. Because of the confidential nature of this material, all figures have been omitted.

(11)

CHARACTER OF THE SAMPLE

The study consisted of 0,000 interviews conducted in 00 cities and towns. Interviews were distributed by size of city as follows:

Population	Number of Cities	Number of Interviews
300,000 and over	00	0,000
100,000 to 300,000	00	0,000
25,000 to 100,000	00	0,000
Less than 25,000	00	0,000
	00	0,000

The study must be considered entirely urban as no interviews were made in small towns or rural districts.

The interviews in each city were distributed by four economic groups in the following proportion:

00%	Economic Group A	Incomes of $5,000 a year and up.
00%	Economic Group B	" " $2,500 to $5,000 a year
00%	Economic Group C	" " $1,000 to $2,500 a year
00%	Economic Group D	" " under $1,000 a year

This separation into economic groups is a fundamental division of the market that will be used throughout the study. Persons in economic group D were asked only a limited number of questions, so will not appear in all comparisons.

Classification of people in these groups is made by using such criteria as section of city, type of home, automobile and electric refrigerator ownership. All interviews were made in the homes, chiefly in the evening. The questions were asked on a family basis, that is, "do you or any member of your family. . . . " The average number of interviews made per interviewer was 00. This low average prevented the answers becoming stereotyped.

Of the 0,000 interviews, 00% were with men and 00% with women. Seventy percent of the interviews were made with the member of the family who usually takes the pictures. . . .

PURCHASE OF THE CAMERA

Conclusion [stated in a phrase.] 00 percent of the cameras were owned by women, 00% by men, and 00% by the family. The ownership of cameras by sex of the owner is not particularly important, however, as the camera is at the disposal of the entire family. The most important fact is who bought the camera.

Conclusion [in a phrase]. This is shown in the following table.

WHO BOUGHT THE CAMERA

Camera Bought By	Economic Group A %	B %	C %	Total	
Owner Male	00.0	00.0	00.0	0,000	00.0
Owner Female	00.0	00.0	00.0	0,000	00.0
Total of self purchase	00.0	00.0	00.0	0,000	00.0
Other member of family:					
Male	00.0	00.0	00.0	0,000	00.0
Female	00.0	00.0	00.0	0,000	00.0
Sex not given	00.0	00.0	00.0	0,000	00.0
Relative:					
Male	00.0	00.0	00.0	0,000	00.0
Female	00.0	00.0	00.0	0,000	00.0
Sex not given	00.0	00.0	00.0	0,000	00.0
Friend:					
Male	00.0	00.0	00.0	0,000	00.0
Female	00.0	00.0	00.0	0,000	00.0
Sex not given	00.0	00.0	00.0	0,000	00.0
Family bought it	00.0	00.0	00.0	0,000	00.0
Don't remember	00.0	00.0	00.0	0,000	00.0
Total	100.0	100.0	100.0	0,000	100.0
Total Male	00	00	00	0,000	00
Total Female	00	00	00	0,000	00
Sex not given—family	0	0	0	000	0

.... of the cameras are gifts. Of these gift cameras, 00% were from family members and 00% were from relatives or friends. The real importance of gift

cameras, however, is shown by separating gifts within the family from those from outside. A camera given within the family is very little different from one that would be purchased by the recipient, as apparently more is known about his preferences.

The ... camera is the most popular gift camera as shown below. Notice the ranking of the ... camera, however.

Gift Cameras	Gift
Reflex	00
Box	00
8 mm. movies	00
16 mm. movie under $100	00
16 mm. movie over $100	00
Cheap miniatures	00
Expensive miniatures	00
Folding	00

On the basis of such studies as these the producer can plan his future production and his sales campaigns.

Exercise: Market.—Prepare a report estimating the opportunities for a dealer in one of the following commodities:

Classroom supplies from a college bookstore conducted by students; consulting services of professional rank in a particular district; lumber from a planing mill for a group of villages; lunches from a counter near a campus; milk from a dairy for adjacents hamlets; sand and gravel for highways from pits in the neighborhood; vegetables from a truck farm close to a manufacturing town.

Material.—There are few plants of importance in which studies of the material used in the process of manufacture are not made from time to time. When a company is dependent upon articles or materials produced by another firm, and when, as often happens, the quality varies because, it may be, fertilizer is not being used in sufficient quantity on the cotton fields, investigations requiring technical analyses of the supplies from different sources are often imperative. When an industry is dependent upon raw material, reports are even more essential.

In these reports are references to kind, source, supply, quality, cost, and transportation. The first topic is self-

explanatory. The second includes the pertinent facts regarding the location and accessibility of the source of supply. The next topic to be considered is the supply itself. How permanent is it likely to be? What, to begin with, is the amount of ore or timber in sight? The answer to the second question often leads to removal or even abandonment. Everyone knows how a lumber mill, for example, follows the cut. What, too, about the dependability of the producer? Is he likely to continue in business or is he likely to surrender to difficulties? Finally, what about government regulation or interference? Is there a possibility of action by the State which will affect the supply as the supply of pulpwood from Canada has been affected by the action of the authorities in Ontario and the Maritime Provinces? Is there a possibility of civil strife as in the oil fields of Mexico? All these questions are significant. Moreover, what is the quality of the material? How does it appear when it is tested in the laboratory or when it is examined in the light of experience? What, too, about cost and transportation? The data on transportation alone may be sufficient to determine the future of an industry as it has determined the destiny of the iron industry in Troy and as it is determining today the destiny of the milling industry in Canada and the United States.

A report on material is therefore arranged in the following order. The outline, however, is intended to be merely suggestive:

I. Premises
   1. Kind
   2. Source
      A. Location
      B. Accessibility
   3. Supply
      A. Permanency
         (a) As Affected by Amount
         (b) As Affected by Producer
         (c) As Affected by Regulation
         (d) As Affected by Interference

B. Quality
(a) As Tested by Analysis
(b) As Tested by Experience

4. Cost
A. Past
B. Future

5. Transportation
A. Water
B. Land
(a) Railroad
(b) Highway

II. RECOMMENDATIONS

Exercise: Material.—Prepare a report on the material used in a local factory.

Transportation.—As already indicated, transportation may be the decisive factor in the success of an industry. Reports dealing with this subject are, therefore, most significant. As a rule, both the physical and operative aspects of the situation are considered. There are always references to the kind of transportation available and to the sources and markets reached by the different agencies. There are also references to the speed and continuity of the service provided. Most important, however, is the question of rates. An engineer who recently made a report upon the possibility of establishing a factory in an Eastern city remarked to his client, with reference to transportation rates, "Nothing else counts." Although the situation covered by this statement is seldom duplicated, rates are always determinative. The cost of securing the raw material from soil, mine, or forest and of delivering the finished product to the proper markets is therefore a matter of concern. By itself, however, the cost may not mean much. It becomes significant only when it is compared with the cost which must be met by actual and hypothetical industries of the same kind in other centers. Studies of this character reveal at once the advantages enjoyed by a community or the disadvantages from

which it suffers. So real are these advantages and disadvantages that the "differential" on grain in favor of Philadelphia and Baltimore has undoubtedly operated against the interests of New York. In the same way, the steel industry at Pittsburgh was at one time menaced by the lower rates granted to the Lackawanna plant at Buffalo. On a smaller scale, fluctuations in business due to rates constantly occur. Reports on transportation are therefore vital necessities.

The outline below is intended to be merely suggestive:

I. Physical Survey
- 1. Kind
  - A. Water
  - B. Land
    - (a) Railroad
    - (b) Highway
- 2. Number

II. Operative Survey
- 1. Service
  - A. Speed
  - B. Continuity
- 2. Rate
  - A. For Local Industry
    - (a) Raw Material from Producer
      - (1) Domestic
      - (2) Foreign
    - (b) Finished Product for Consumer
      - (1) Domestic
      - (2) Foreign
  - B. For Competing Industries
    (As for A)
  - C. For Hypothetical Industries
    (As for A)

Plant Operation and Production.—Often an expert may be called in to study a plant from the point of view of its

efficiency in production. Such studies may deal with products, manufacturing routine, layout, labor, and the like. A typical report, made by the Stone and Webster Engineering Corporation, concerning manufacturing specialities, covers, with many specific and general recommendations, the product, manufacturing, plant and departmental layout, labor, sales, financial problems, and organization. Two excerpts from it will indicate the type of problems presented and the recommendations proposed:

(12)

MANUFACTURING

Inactive and slow-moving stock, work in process and finished goods, as a matter of regular policy, should be removed from the space required for active goods, probably to the warehouse. The use and disposition of these goods should be made the definite responsibility of some one individual, who, working with the sales, development, and manufacturing departments, will continually liquidate them. Items which do not offer a reasonable possibility of sale or use in products should be disposed of as waste. It might be advisable to create a separate department for this function to be known as the "Salvage Department." Reports should be made currently to the Executive Committee showing progress being made in the use or disposition of these items.

We find that there is an excessive number of small orders which cause unnecessarily high manufacturing costs. By increasing the size of the orders, not only will the collating cost be reduced, but by giving operators longer runs, piece rates might possibly be adjusted. We recommend that the every-day line of . . . be manufactured for stock in one or two gross lots and that shipments be filled from stock. The situation at the end of the run of season goods should be studied to see to what extent short runs in these items might be eliminated. It is our opinion that the risk involved in carrying over a moderate inventory of items which may be discontinued is substantially less than the excessive manufacturing cost caused by the present arrangement.

LAYOUT

The present layout is needlessly confused, with the result that manufacturing costs are unnecessarily high. The condition in the . . . Department has been particularly bad and as a result it is

difficult to supervise operations adequately. The manufacturing operations on the second and third floors are spread out too much for efficient supervision and the flow and handling of work in process could be greatly improved.

We recommend that some one person in the organization be designated to study the layout of the entire factory with a view to minimizing the handling of materials and to facilitating straight line flow of material within the departments. He should report his findings to the Executive Committee and be responsible for putting into effect all changes approved by the Executive Committee.

A preliminary layout of the . . . Department has been discussed with Mr. Jones. This contemplates placing the . . . machines along the north wall, facing each other in pairs where one operator and a girl can serve two machines, packaging on three belt conveyors working across the room, packing at the side opposite the machines and delivering cases by a belt conveyor and chute to the shipping room. We estimate the cost of this rearrangement, together with the necessary conveyor equipment and chute, to be approximately $7,000, and the resulting saving to be at the rate of approximately $6,000 per year.[5]

Physical Aspects.—Like other reports upon special topics, reports upon the physical aspects of a plant may be developed from two points of view. They may be "improvement reports" pointing toward efficiency in procedure. A report of this character made during the World War by an engineer employed by an iron company reduced materially the number of laborers needed in the process of manufacture. During the same period, a report by an industrial expert connected with a textile factory lessened notably the time required for routing the product from department to department. In addition to such reports, "appraisal reports" dealing with real estate, buildings, and equipment have become essential under modern conditions. At times, also, a report may cover both plant and operating conditions, appraising the value of raw materials as well as plant, and examining operations as well as physical properties.

These reports always contain a description of the real estate included in the property to be appraised. An estimate based

[5] Reprinted from a private report, by permission of Major John Coffee Hays, Vice-President, the Stone and Webster Engineering Corporation.

on invested, assessed, and market values can usually be made without difficulty. The description of the buildings, which is developed by reference to their number, to their size, and to the material of which they are constructed, is likewise not a serious problem. It must be clear to everyone, however, that the value of the buildings will depend, to some extent, upon their convertibility as well as upon their use. In most reports, the description is therefore supplemented by a note regarding the manner in which they can be adapted to other needs that may arise. In so far as it affects the valuation, this feature is most important. Even under the most favorable circumstances, an accurate estimate is not easy. Ordinarily it can be reached only by considering the assessed, insured, duplicate, and convertible values, with due reference to adjacent property. In that part of the report which deals with equipment, the description includes notes upon the number, character, and arrangement of the units. In this connection, obsolescence and depreciation are highly significant. In certain industries, machines become out of date almost as soon as they are installed. In other industries, deterioration is very rapid. Occasionally, therefore, it may be possible to portray the condition of the machinery in a plant by relating both obsolescence and depreciation to the normal period of service. The ratios established in this way will help greatly in the final estimate.

In general, an appraisal report consists of two parts. One of these is devoted to brief expositions of the topics mentioned in the last paragraph, and the other is devoted to detailed accounts covering the items treated. The scheme of each part is outlined below:

- I. Real Estate
  - 1. Description
    - A. Site
    - B. Area
  - 2. Valuation
    - A. Invested
    - B. Assessed
    - C. Market

II. BUILDINGS
- 1. Description
  - A. Number
  - B. Size
  - C. Material
- 2. Use
  - A. Present
  - B. Possible
- 3. Condition
  - A. Maintenance
  - B. Depreciation
- 4. Valuation
  - A. Invested
  - B. Assessed
  - C. Insured
  - D. Duplicate
  - E. Convertible
  - F. Actual

III. EQUIPMENT
- 1. Description
  - A. Character of Units
  - B. Number of Units
  - C. Arrangement of Units
- 2. Use
  - A. Present
  - B. Possible
- 3. Condition
  - A. Obsolescence
  - B. Depreciation
- 4. Valuation
  - A. Duplicate
  - B. Convertible
  - C. Actual

An illustration of the technique as applied to a going concern is a *Report on Plant and Operating Conditions of the ....Company,*[6] made in 1935 by the Stone and Webster Engineering Corporation.

After a general introduction, a history of the company, and a list of products, the report surveys each plant operated by the company, describing in detail the operations of mining and preparing the company's products, and comments on such items as the buildings and mining properties, the labor situation, and the capacity of the plant. A special section summarizes the opinion of the writers on appraisal, values, and personnel. The final pages of the report inventory the ore reserves and evaluate the deposits.

Representative paragraphs will indicate the method of reporting on the examination of such properties:

(13)

The rock deposit lies about 80 feet below the ground surface and is approximately 4 feet thick. Rock is mined in rooms leaving sufficient pillars to hold the roof, and hauled to the shaft by electric motors. The cars are hoisted to the mill house and dumped into weigh hoppers and the weight of each load recorded. The gypsum deposit is mined under a royalty agreement, calling for the payment of ... cents per ton of rock taken out.

From the weigh hoppers the rock is delivered to the primary crusher by a conveyor. The crushed rock is then dried to remove surface moisture, ground in Raymond mills and conveyed to the calciners. The plant is equipped with three batch type calcining kettles. After calcination the gypsum is delivered by conveyor to the storage bins in the plaster warehouse or board plant as required. Plaster is passed through tube mills before bagging for shipment. Sand, fibre or pulp is added before bagging as required to make sanded, wood pulp or fibred plaster. Plaster for board making is used direct from the calciners. It is cooled where necessary and thoroughly mixed with the wet pulp and other

[6] A private report in typescript from which the authors are privileged to quote through the courtesy of the Stone and Webster Engineering Corporation.

ingredients by agitators on a moving belt known as the wet end. The mass is ground in a ball mixer and spread evenly on the paper. The top paper is applied and the board shaped by rollers as it passes to the conveyor. The conveyor is approximately 600 feet long, the first 300 feet being a belt conveyor and the last section rollers. The set of the plaster is timed so that when the board reaches the roller section of the conveyor it has set sufficiently to travel on the rolls without breaking. The machine produces a board 4 feet wide at the rate of 40 to 50 feet per minute. At the end of the conveyor the sheet is automatically cut to length, transferred horizontally, and fed into the drying oven conveyor. When the board comes out of the oven it is inspected and piled on skid platforms for warehousing.

The buildings of the plant are well constructed and laid out. The equipment is all suitable for its purpose and well maintained. Full advantage is taken of conveyors and manual handling kept at a minimum.

Practically all the labor has been trained by the Company and very little skilled labor is required except for maintenance. Forty to forty-five men are employed in the mine at the present, working one shift of forty hours per week and sixty men are required in the plant. The miners are paid on the basis of tonnage rates. Loading and packing labor is paid on tonnage rates, the balance of the labor being paid on an hourly basis.

PERSONNEL

The plant superintendents all appear to have a thorough knowledge of their work and to have their plants well in hand. Labor in the plants appears to be intelligent and a good type. Very little skilled labor is required in any of the process work and labor costs are low.

We believe that the Company's cost system is good and in sufficient detail to permit effective executive control.

Department heads whom we contacted appear to us to be aggressive and the departments smooth running.

All plants are equipped with control laboratories and daily checks are made of output. A research laboratory is maintained at the Company's main office

which in addition to research work supervises the work of the plant laboratory.

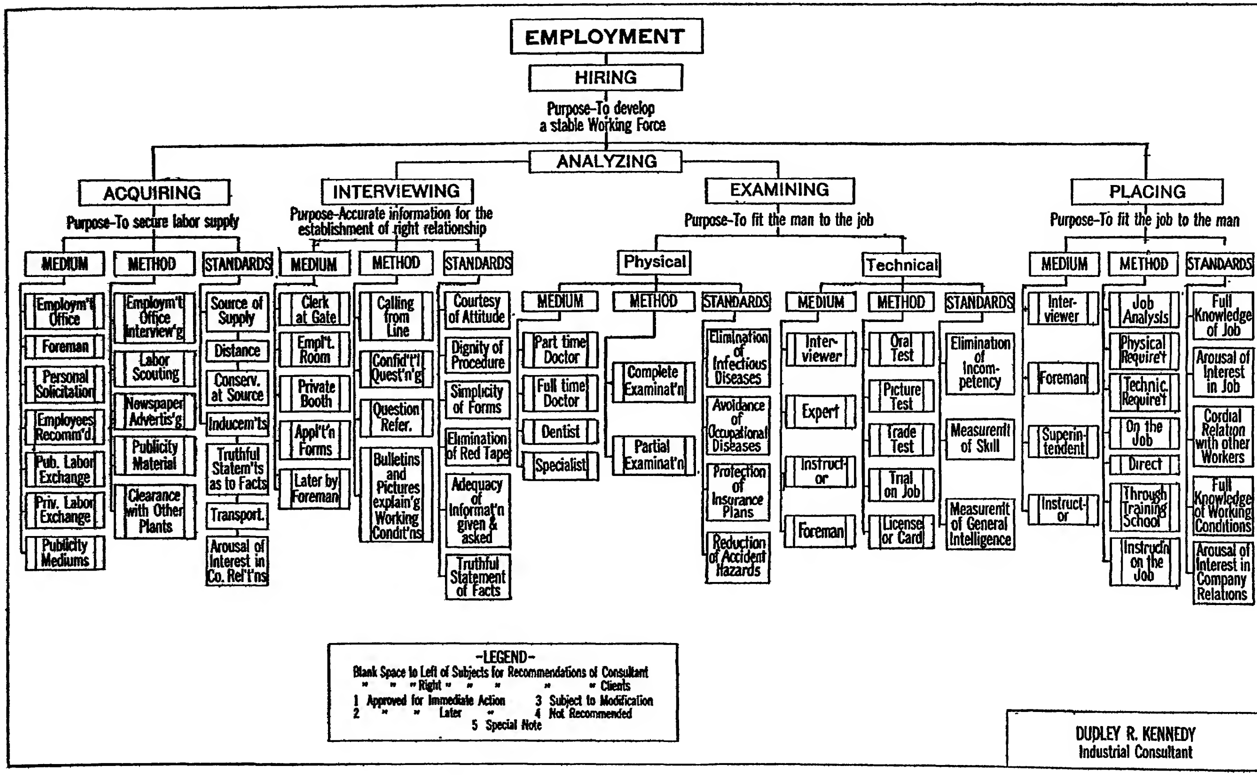
ORE RESERVES

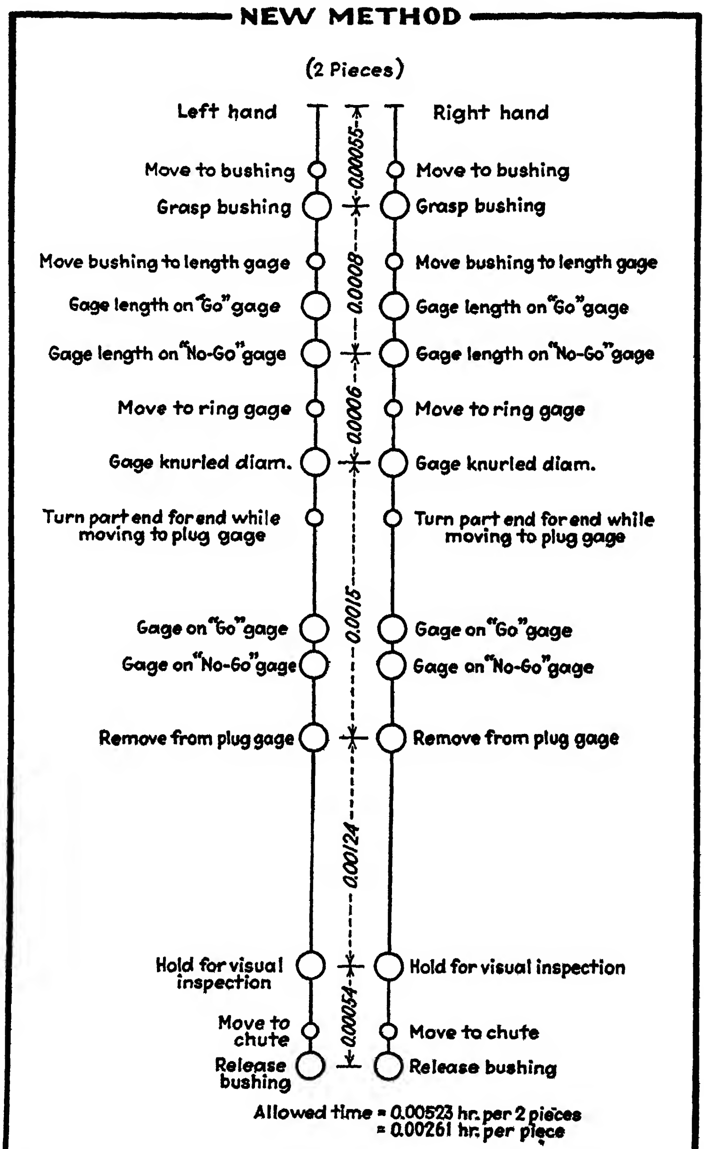
The deposit now being worked under a leasehold has been mined for a considerable time and the workings have reached the edges of the deposit. Borings indicate that there is rock under a section of land just ahead of the present workings. The intervening soil is poor but it is believed that the expense of driving a tunnel to the new deposits will not be prohibitive. By thinning out the room pillars and division walls, and removing more rock from the roof and floor where safe, from . . . to . . . tons of rock may still be recovered from the present workings. The plant requirements at full capacity of the kettles are approximately . . . tons per day, or . . . per year. If the business conditions should permit the operation of the plant at that capacity the present ore deposit would be exhausted in . . . to . . . years.

The Company has recently acquired a favorable leasehold on a gypsum deposit close to the plant which is estimated to contain approximately . . . tons of recoverable gypsum.

Exercise: Physical Aspects.—Prepare an "appraisal report" upon the plant of a small industry or business such as those mentioned on pages 349-350.

Administrative Aspects.—Since the development of the science of management, industry has come to rely increasingly upon the recommendations of psychologists and personnel research experts; and every corporation of any size now maintains a personnel department. The organization of a company is as important as its plant; and recent studies as far apart as those on inter-departmental relations and those dealing with time-and-motion, fatigue, and unemployment insurance indicate the wide scope of the field. Many such studies are available in the bulletins of the Policyholders Service Bureau of the Metropolitan Life Insurance Company and the American Institute of Management. Magazines such as *Factory Management and Maintenance*, *The Personnel Journal*, and the two journals of


EMPLOYMENT
HIRING
Purpose-To develop a stable Working Force
ANALYZING
ACQUIRING
Purpose-To secure labor supply
MEDIUM
Employm't Office
Foreman
Personal Solicitation
Employees Recomm'd
Pub. Labor Exchange
Priv. Labor Exchange
Publicity Mediums
METHOD
Employm't Office Interview'g
Labor Scouting
Newspaper Advertis'g
Publicity Material
Clearance with Other Plants
STANDARDS
Source of Supply
Distance
Conserv. at Source
Inducem'ts
Truthful Statem'ts as to Facts
Transport.
Arousal of Interest in Co. Rel't'ns
INTERVIEWING
Purpose-Accurate information for the establishment of right relationship
MEDIUM
Clerk at Gate
Empl't. Room
Private Booth
Appl't'n Forms
Later by Foreman
METHOD
Calling from Line
Confid't'l Quest'n'g
Question Refer.
Bulletins and Pictures explain'g Working Condit'ns
STANDARDS
Courtesy of Attitude
Dignity of Procedure
Simplicity of Forms
Elimination of Red Tape
Adequacy of Informat'n given & asked
Truthful Statement of Facts
EXAMINING
Purpose-To fit the man to the job
Physical
MEDIUM
Part time Doctor
Full time Doctor
Dentist
Specialist
METHOD
Complete Examinat'n
Partial Examinat'n
STANDARDS
Elimination of Infectious Diseases
Avoidance of Occupational Diseases
Protection of Insurance Plans
Reduction of Accident Hazards
Technical
MEDIUM
Inter-viewer
Expert
Instruct-or
Foreman
METHOD
Oral Test
Picture Test
Trade Test
Trial on Job
License or Card
STANDARDS
Elimination of Incom-petency
Measurem't of Skill
Measurem't of General Intelligence
PLACING
Purpose-To fit the job to the man
MEDIUM
Inter-viewer
Foreman
Superin-tendent
Instruct-or
METHOD
Job Analysis
Physical Require't
Technic. Require't
On the Job
Direct
Through Training School
Instruct'n on the Job
STANDARDS
Full Knowledge of Job
Arousal of Interest in Job
Cordial Relation with other Workers
Full Knowledge of Working Conditions
Arousal of Interest in Company Relations
-LEGEND-
Blank Space to Left of Subjects for Recommendations of Consultant
" " " Right " " " " Clients
1 Approved for Immediate Action
2 " " Later "
3 Subject to Modification
4 Not Recommended
5 Special Note
DUDLEY R. KENNEDY
Industrial Consultant



A Typical "Time and Motion Study" Chart for an Industrial Process

(From an article in *Factory Management and Maintenance*, March, 1936, p. 105, by G. J. Stegemerten)

the American Management Association, *Management Review* and *Personnel,* also contain numerous reports. These reports make no special demand in preparation or composition beyond the technical skill required to secure the necessary information. Interesting and effective charts for presenting results have been developed. An excellent specimen is the chart for studying relations between employers and employees by the late Dudley R. Kennedy, industrial consultant, associated with Cluett, Peabody and Company. This chart consists of fourteen sections, of which a typical one is shown on page 377.

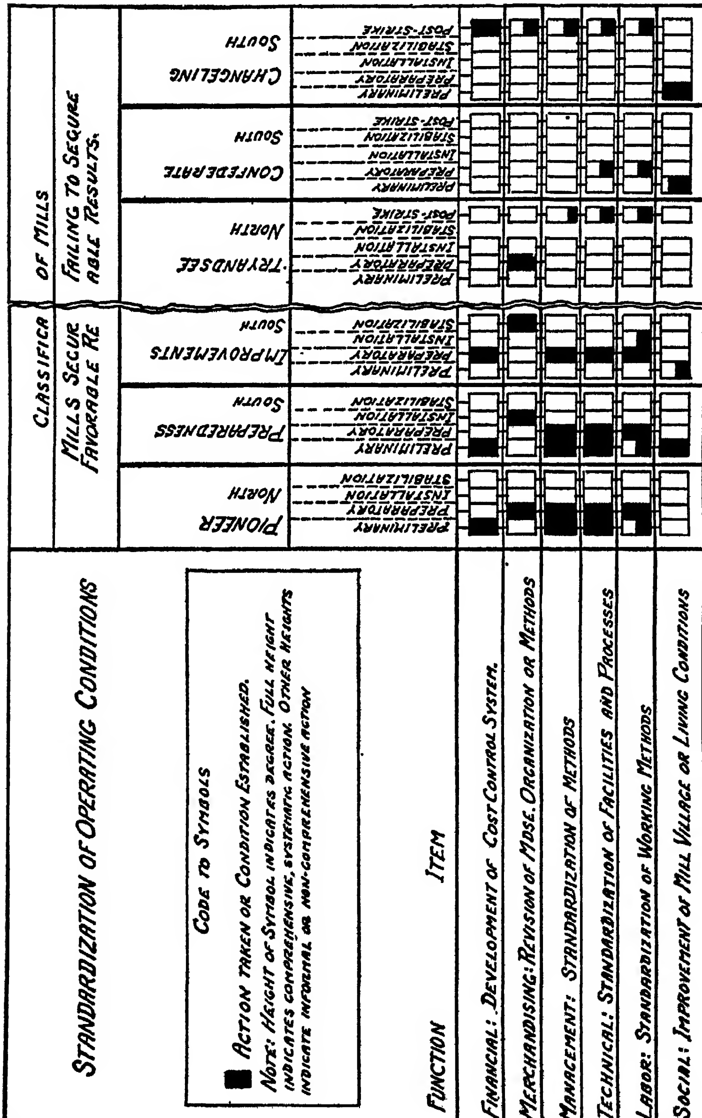
A time-and-motion study chart is also reproduced to show how the science of management has developed a short-hand system for explaining its activities.

The next chart is reproduced from "A Preliminary Report of a Study of Some Human Problems in the Management of Technological Change," by Eliott Dunlap Smith, of the Yale University Institute of Human Relations, and printed in *Mechanical Engineering* (February, 1934). It illustrates "a graphical method of presenting comparatively the extent of action" of a group of textile mills which introduced the "stretch-out system" in the major managerial functions during the four periods of the "stretch-out" installation. Referring to the importance of such studies and of a trained personnel management, Mr. Smith concludes his report with these statements:

(14)

A far-reaching change in technological methods is a major disturbance of human relations and may have serious human and social consequences. The human problems of methods change, moreover, are greater than those of the introduction of labor-saving mechanism. The dangers also are far greater if, instead of a series of small changes, an accumulation of lesser developments are concentrated into one abrupt major change. They are greater also if the change occurs in a period of depression. For all these reasons, the human distress and economic failures arising out of technological change will be reduced if scientific study and progress are continuous instead of occurring in such spasms as are promoted by economic adversity.

The dependence of the workers upon the skill of management and upon its interest in their welfare, and the dependence of the



Fragment of Function-Period Chart

(From "A Preliminary Report of a Study of Some Human Problems in the Management of Technological Change," by Eliott Dunlap Smith, *Mechanical Engineering*, Vol. 56, p. 74, February, 1934)

(Illustrating a graphical method of representing comparatively the extent of action of the individual mills in the major managerial functions during each of the periods. For the sake of simplicity this example of our charts has been confined to the single item of "standardization of conditions.")

company upon the loyalty and coöperation of its workers, are both far greater than in normal times. Hence, in a major technological change, good-will with employees is an asset comparable to good financial credit; and good management must be good personnel management.

Illustrations showing the range and scope of administrative reports follow.

Naturally, one source of information in reports of this kind is the interview, as indicated by M. L. Putnam's report, *A Plan for Improving Employee Relations on the Basis of Data Obtained from Employees.* In his study the author, who is chief of the Industrial Research Division at the Hawthorne Works of the Western Electric Company, discovered by this method many significant facts concerning morale and the relations between employees and supervisors as they affected plant production. The conclusions growing out of his study are reproduced:

(15)

We may, in conclusion, summarize the values in this plan. It must be realized, of course, that it is still in the early stages of development and as yet all the values are not definitely determinable.

First, the interviewing of employees has had very desirable effects upon the employees themselves. Those interviewed have had a chance to fully express themselves. . . . Supervisors have sometimes commented that such employees are easier to supervise; and employees themselves have said that they felt better after such a hearing as the interview affords. In addition, there is the probability that interviewing improves an employee's morale because he is reassured that the management wants to better his surroundings, and he feels that he is important enough to have his opinions sought.

Second, the Company receives information and data from employees which have not otherwise been received and which serve as a basis for studying employee relations and for improving plant conditions. In addition, we are getting first hand information as to the effect which all of our personnel activities, such as the thrift plans, pension and sick benefit plans, athletic activities, and vacations, have upon employees. This in itself is invaluable.

Third, the very operation of the plan makes for improved supervision. Many employees have remarked that supervision improved after interviewing was begun. It seems only natural that a supervisor who knows that his employees are going to express their favorable and unfavorable thoughts will give more attention to his method of dealing with them.

Fourth, the supervisory training made possible through the comments of employees is far superior to any of our previous programs. It is most interesting to supervisors because the employees' comments are critically made and, for all the supervisor knows, he may be the subject of the employees' remarks. It has never before been possible for our employees to criticise their supervisors so freely without fear. Under this plan they may not only speak freely, but their opinions benefit their own and other supervisors as well. Most of the supervisors are enthusiastic because they see considerable value in this phase of their training. Such an indirect method of getting employees' complaints back to the supervisor is far superior in its results to the old method of direct accusation and argument.

Finally, the comments from employees have convinced us that the relationship between first line supervisors and the individual workman is of more importance in determining the attitude, morale, general happiness, and efficiency of that employee than any other single factor. We believe we have progressed further in knowledge of employee relations during the short time this plan has been in operation than in all the previous years of the Company's existence.

Similarly, in a survey entitled *The Five-Day Week* (1931), the Eastman Kodak Company investigated the economic and industrial significance of the shorter work week as applied to industry in general and to its own organization in particular. The methods used in the preparation of the report[7] may be regarded as typical. It consists of seven sections:

Foreword
General Summary
Introduction
Extent of Five-Day Week
Economic Aspects

---

[7] Typewritten report made available through the courtesy of the Eastman Kodak Company.

Production Under Five-Day Week
Cost of Five-Day Week
Problems of Application in Industry
Application in Specific Industries
Five-Day Week and the Eastman Kodak Company

The data were obtained by an examination of the literature available, especially "studies made by the National Industrial Conference Board, Princeton University, and the United States Department of Commerce," by interviews, and by first-hand investigations conducted by the Statistical Department of the Eastman Kodak Company.

Characteristic sections of the report will illustrate form and style:

(16)

I. Production Under the Five-Day Week

Production Speeds

It is interesting to note that where there was a reduction in weekly hours, only 19.2% reported increased outputs, whereas where hours remained the same, increased production was reported by 43.9% of the companies. It should be realized, however, that the figures refer to production for the entire week and not speed of production. In this light, it shows that nearly 70% of the companies which reduced weekly hours have suffered no loss in total weekly output and are therefore obtaining sufficiently increased hourly speeds to at least make up the entire loss of hours. Only one concern increased the hours, but the weekly production remained the same, thus indicating slower speeds.

Production by Clerical Workers . . .

Incentives to Greater Efficiency . . .

Fatigue

. . . Statistical appraisals of the factors of fatigue, mental and physical, are difficult. The data does show, however, that productive efficiency is greatly stimulated by favorable conditions and that shorter hours of labor generally result in a high rate of productivity per hour.

Length of Day and Productive Efficiency

The shorter work week may take the form of less hours per day or less days per week. The six-hour day as adopted by the Kellogg Company with about 2,000 employees, has accomplished the following results:

a. It has provided more employment. (They hired 430 more workers.)

b. It reduced their overhead costs by utilizing their machinery and equipment more efficiently and more continuously. (They operate on four six-hour shifts each day, with no allowance for lunch periods.)

Efficiency of Production by Days

A recent report, "Restriction of Output Among Unorganized Workers," made by the Social Science Research Council, indicates that the over-speeded American industrial worker is "largely a myth." The investigators in this study actually donned overalls and were hired as laborers on many jobs. They report 223 instances of restrictions of output by the workers in 105 establishments. Instances of where speeds could be increased two and three times were frequent, and purposely slowed speeds to deceive the time study men was common practice.

Antioch College was largely responsible for the initiating of the study. Its president, Dr. Arthur E. Morgan, in commenting on the report says: "A six-hour day or a five day week, or both, may seem to be radical innovations, yet it would give increased leisure, make possible increased consumption, and add quality and interest to our lives. At the present time, we are getting probably less than the equivalent production of a six-hour day and a five-day week but with destruction of self-respect and character, by the policy of loafing on the job and restricting output."

Personal Opinions on Effect of 5-Day Week on Production

Henry Ford: "It has now been sufficiently demonstrated to us that the five-day week for men brings better results than the six-day week. Simply on the point of production it is as much better than the six-day week as the eight-hour day is better than the ten-hour day. . . . We know from our experience in changing from six to five days and back again that we can get at least as great production in five days as we can in six, and we shall probably get a greater production rate for the pressure will bring better methods."

John J. Raskob (1929): " . . . In lines where demand is at the peak, some manufacturers are acting upon their faith that skilled, willing and well-paid workers will produce as much in five days as in five and a half or six. Results are justifying them, and in my opinion the next few years will see the comparatively rapid and all but universal adoption of the five day week by the major industries."

Flexibility of Production . . .

II. Conclusion

The five-day week is practical; it strikes at the fundamental problem of unemployment; it will not seriously affect costs; it provides an incentive to more efficient production and will give the needed extra leisure to labor, resulting in improved morale and health.

The Eastman Kodak Company should be among the most active to sponsor and further the general adoption of the five-day week. The direct benefits to the Company through increased sales are substantial and would justify active measures to encourage the movement which at the present time is "ripe" for stimulation.

Exercise: Administrative Aspects.—Prepare a report upon the technique developed in the choice of candidates for a college activity such as those listed on page 178. Point out carefully its merits and defects.

Result of Operation.—It has already been pointed out that the result of operation in the case of a periodic report is expressed in terms of income and expenditure, of assets and liabilities. The purpose is to make clear the financial condi-

tion of a company at the end of an administrative unit such as a year. A statement of this kind is prepared, as a rule, by the employees of the corporation to which it refers. On the other hand, every industrial examination of any scope includes a survey of the same character. In such surveys, however, emphasis varies with the problems to be considered. And these problems are seldom matters of dollars and cents.

Nevertheless, the examination report sometimes deals with finances only. The directors or stockholders of a company may desire an independent analysis of its affairs. A banker or broker may wish to know the extent of its resources. Under these circumstances, an expert may be entrusted with the task of investigation. Since he will probably be an accountant instead of a technologist, and since the character of his report as fixed by custom has already been described in detail by Mr. Fitting in Chapter XXIV of *Business Writing*[8] (New York, 1920), it does not seem necessary to analyze it here.

It is necessary, however, to emphasize the fact that the old-fashioned balance sheet is no longer regarded as an index of a corporation's stability. Today every financial institution looks beyond it to the factors, mentioned on page 340, which determine its success. Not the least of these factors is the initiative and integrity of those who are responsible for its progress.

[8] Volume II of *Language for Men of Affairs.*

CHAPTER 16

RECOMMENDATION REPORTS—CONSTRUCTION

Character of the Construction Report.—As explained in Chapter 14, the operation report and the construction report may each encroach upon the functions of the other. Although there is no hard-and-fast line of division between the two, and although neither, as a matter of fact, is entirely literal or entirely graphic in form, one element or the other is usually supreme. In the construction report, design is paramount; and in it, therefore, illustration plays a dominant part.

Arrangement of the Construction Report.—It has already been intimated that a recommendation is necessarily based upon the kind of knowledge accumulated in the preparation of an information or an examination report. Indeed, the operation report is a mere extension of one of these primitive forms. The data accumulated through experience, remote or immediate, become the premises of the conclusions submitted as recommendations. As these recommendations may be appended to the facts presented, so also may diagrams illustrating the plans proposed. Under such circumstances, however, the fundamental data are arranged according to a scheme which has been fixed by usage. As explained in succeeding paragraphs, it is especially adapted to the needs of the layman unfamiliar with the technique of building or manufacture.

Object.—The first phase of a construction report is an indication of its purpose. As a rule, the object may be made clear by a brief commentary on the function of the system, structure, mechanism, or machine designed. Thus, the *Preliminary Report on Electrical Indicator for High Speed Internal Combustion Engines,* Royal Aircraft Establishment *Report* E. 2197 (January 16, 1920), begins with a reference to the fact that the indicator in question "is designed to build up an indicator diagram over a period of several cycles." Usually such a defi-

nition is all that is required. At times, however, especially if the report marks an advance in technique, it may be advisable to include a note on the need or reason for the development cited. This method is adopted by Edward W. Davis in *A New Machine for Concentrating Minnesota Wash Ores,* University of Minnesota School of Mines Experiment Station Bulletin 6:

(1)

During the past year the Mines Experiment Station has received several requests from mine owners and operators for information regarding some means of washing ore in a moderately priced plant of a more or less portable nature. With the hope of answering such requests, the Station undertook a series of experiments leading toward the development of a new machine for washing ores. The result of the experimental work conducted by E. W. Davis was the development of a machine which has been called the Dorr Ore Washer.

Scope.—As in the examination report, and also the research report, a statement regarding the scope of the exposition is always of assistance to the reader. It will enable him to follow the discussion with more than ordinary confidence. This statement should include references to the next two topics, the selection of a particular type of system, structure, mechanism, or machine, and the determination of its special characteristics.

Selection of a Particular Type.—The purpose of the first of these topics is the selection of a type to serve as a basis for the design to be recommended as most suitable.

The arrangement is exemplified in the following passage from *A Report . . . Containing a General Plan for the Improvement of Milk River, Montana* (Washington, D. C., 1933):

(2)

IV. Flood Control Plans

A. *General Considerations*

Possible Plans

186. The more important general methods of obtaining flood protection on the smaller alluvial streams are (a) cleaning and

enlargement of natural channels, (b) channel straightening, (c) levees, (d) storage, or detention reservoirs, (e) combination of two or more of these. On the larger alluvial streams the by-pass method of flood control can be economically and efficiently used. In general, on minor tributaries, with narrow valleys, smaller flood flows, and the absence of large areas of swamp or low-priced land, the by-pass or the diversion method of flood control is uneconomical.

187. The cleaning and enlargement of the natural channel will provide some measure of flood protection and may be quite effective in small streams. The general effect of this method is to pass a greater volume at a reduced flood height by means of a larger cross section and less impediment to flow. A relatively small amount of excavation and cleaning usually suffices to double the capacity of the channel itself, with a corresponding decrease of flood heights over the overflow areas. When this method has been applied, there is no assurance that the improvement will be sufficiently maintained to provide flow capacity equal to the original design. Moreover, some provision must be made for the increased discharge immediately below the improved section, unless there is a steep natural slope below that will remove the larger volume without causing a backwater effect. In addition, it should be noted that only in rare instances can the natural channel be sufficiently enlarged and improved to reduce the maximum flood stage to a point where the resulting damage is relatively small.

188. In general, flood control by channel straightening is regarded as unsound, except perhaps, on very small tributaries. General experience in the Missouri Basin, with respect to channel straightening as a means of flood control, shows conclusively that such measures are in direct conflict with fundamental physical laws governing the behavior of a river channel in an alluvial valley. Invariably channel shortening by means of cut-offs or new channels results in a temporary decrease of flood stages in the immediate vicinity of the works but increases flood stages below. The increased grade creates high velocities that accelerate bank erosion, and experience shows that in time the stream will resume its natural state, unless large expenditures are made to hold the channel.

189. The use of levees for the protection of agricultural lands subject to overflow in the Milk River Basin is complicated by the intricate network of irrigation canals that have been constructed

and are now in operation throughout the greater part of the larger and more desirable areas to be protected. Like all alluvial rivers the land adjacent to the river banks is higher than that along the edge of the valley. Consequently, the main canals for the various irrigation projects have been located along this high ground and parallel to the stream course in order that the adjacent areas may be more easily irrigated. In view of the excessive run-off from minor tributaries, resulting from heavy rains and immediately following the warm chinook winds, it would be extremely difficult to select units of sufficient size to produce an economical levee cost. If large units were selected, it would be a difficult problem to adequately care for sidehill and interior drainage. It is also impractical to provide protection for the entire area of the river bottoms on an alluvial stream such as the Milk. In order to provide the necessary floodway area the setback of the levees must be such as to leave a considerable portion of the valley unprotected. The portions unprotected, in most cases, include important irrigation structures and canals that would be endangered by the erosive action of the flood water to be confined between levees. Narrower floodways would require higher levees at a cost greater than would justify the protection of the additional area.

In this part of the report the arrangement is substantially that suggested below:

I. A definition of the system, structure, mechanism, or machine to be designed.
II. A classification of the types which have been evolved.
III. A study of the advantages and disadvantages of each type.
IV. A selection of the type which seems best suited to the circumstances.

As hinted in the passage quoted, a writer should avoid anything suggestive of argument. Under no circumstances should he assume that his exposition is a brief in favor of a particular type. It is his business to indicate the facts and the conclusions which spring from them. The decision is a matter for his client.

The way in which this scheme may be adapted to a study of the types assumed by a mechanism is exemplified in "Ther-

mometers for Aircraft Engines," by E. F. Mueller and R. M. Wilhelm, in *Power Plant Instruments,* National Advisory Committee for Aeronautics Report 129 (1922):

(3)

Possible Types of Thermometers

The types and forms of distance-reading thermometers available for practical use may be classified under two general heads; namely, electrical and pressure. A consideration of the relative advantages of these two general types led to the adoption in this country of the pressure instrument for airplanes on account of smallness in size and weight, ruggedness of construction, and immediate availability. This last factor was important since the pressure thermometers on the market could be easily adapted for airplane work, while it would have been necessary to evolve practically a new type of electrical indicator to fulfil the conditions imposed.

A type of electrical thermometer taken from captured German planes consists essentially of a resistance thermometer connected with a small ohmmeter and a battery. It indicates the temperature only at the time when a push button switch is operated.

The advantages of this type of instrument over the pressure thermometers are sensitivity to rapid changes in temperature and absence of errors due to change in atmospheric pressure or change in temperature of connections. However, its greater complexity, costliness, weight, and inconvenience in that the pilot must operate the push button to observe the reading offsets the advantages above enumerated.

Considerations Governing the Selection.—Although it is impossible to classify with any degree of definiteness the considerations governing the selection of a particular type, they fall mainly into three categories:

1. Adaptability
2. Cost
3. Popularity

The first question which must be asked is one regarding adaptability. Is the type proposed suited to the circumstances? Unless it meets adequately the needs of the case, it may be dismissed without hesitation. Although it is true that the other touchstones mentioned may sometimes dictate a choice that is

far from satisfactory, it is also true that there are always requirements which are fundamental.

Often the cost is decisive. It may lead at once to the elimination of certain types. In considering those that remain, the responsibility for the proposed construction must be thrown into the balance. If the enterprise is a private undertaking, a heavy initial expenditure may be justified. If it is a public work, in which the expense is to be met by a sinking fund, the project demanding the least annual outlay will ordinarily seem most acceptable. In both cases, it should not be forgotten that the total expense bears a definite ratio to the value of the property benefited.

In a public work especially, the element of popularity is important. Other things being equal, the type of system, structure, mechanism, or machine which is the simplest and the most obvious, and which will therefore be the easiest to explain and to establish in the confidence of the community, possesses undoubted advantage over other types. Like the sales agent, the author of a construction report is most successful when he gauges accurately the attitude of his clients. Any recommendation should be a study in adaptation.

In the choice of type for the bridge over the Hudson River, the Port of New York Authority was confronted with several possibilities, which are discussed by the chief engineer, O. H. Ammann in his paper, "The George Washington Bridge: General Conception and Development of Design," *Transactions* of the American Society of Civil Engineers for 1933. The following paragraphs, pages 28-37 of the paper, illustrate an effective presentation of the factors governing type of structure.

After indicating that the most economical length of the river span was 3,500 feet and that moving the New Jersey pier about 800 feet further into the river would not decrease the expenditure because of the increased cost of a deeper foundation, Mr. Ammann continues:

(4)

There appears to be a widespread, but unwarranted, impression in the minds of engineers and others that length of span is the

predominant factor in the economy of a large bridge; whereas, in many cases, such as that of the George Washington Bridge, a careful and rational analysis of conditions and costs would indicate that length of central span is a lesser factor. . . .

The great central span and the possibility of the construction of solid, comparatively inexpensive, cable anchorages should force any student of the economics of long-span bridges to the conclusion that a rationally designed suspension bridge would be economically superior to any other conceivable type, not considering its superior aesthetic merits. . . .

. . . it is quite evident that even today engineers have different conceptions as to the relative economic merits of different types for long spans. . . . Indeed, if the many designs are compared . . . a perplexing diversity of conceptions is found. . . . [Figures 17, 18, and 19, not here reproduced, show illustrations of ten different designs proposed at various times.]

The cantilever, pure or hybrid, may be dismissed as a possibility by referring to the exhaustive investigations of the War Department in 1894. . . . Comparing this with a suspension bridge of a type shown in Figure 18 (a) [omitted] the Board of Engineers found that even for a central span of 3,200 ft. the suspension type would not be materially more expensive than the proposed cantilever.

Under present-day conceptions of the rational design of the two types of bridges, and in particular under conditions such as exist at the George Washington Bridge, the economic difference between the two types is materially accentuated in favor of the suspension type. The superiority of the suspension type over the arch, both economically and aesthetically, is less obvious; and the site of the George Washington Bridge, with its solid rocky shores, might invite an investigation of the latter type. The comparison of an arch with a span of 1685 ft. over the Kill Van Kull in 1928 proved this type to be more economical than that which was considered an equivalent suspension bridge with a central span of 1,522 ft. largely because of expensive anchorages required by the latter on account of the low level of the ground. . . .

A remarkably bold and very creditable design for an arch bridge across the Hudson River was made in 1889 by the English engineer, Max am Ende. . . . He claimed at the time that his arch would be more economical than the suspension type proposed by Mr. Lindenthal. In accordance with present-day conceptions in design there can be little doubt that such an arch would be very much

more expensive, and a great mass of steel at the height of about 600 ft. above water level would not be as attractive in appearance as a graceful suspension bridge, provided the latter is without clumsy stiffening trusses, such as were embodied in several of the early designs for a Hudson River bridge.

All later designs show preference for the suspension type. For a span of 3,500 ft., under conditions permitting a relatively light stiffening system and inexpensive anchorages, as in the case of the George Washington Bridge at Fort Lee, the suspension type is unquestionably far more economical than any other type.

From time to time there have been proposed . . . combinations of the pure suspension type and other types. Whatever may be the claims of scientific or economic merit of such hybrid types (and it is very doubtful in the writer's mind that they are justified because of the lack of structural simplicity and clearness of function of such incongruent systems), they cannot satisfy aesthetic principles.

. . . Even Mr. John A. Roebling, troubled by the problem of finding means to provide sufficient rigidity, seriously considered a combination of a rigid truss with suspended cables, but his good common sense finally led him to the simple suspension design so admirably illustrated by the Brooklyn Bridge.[1]

Exercise: Selection of a Particular Type.—Choose one of the following topics which you can relate to conditions with which you are familiar. Classify the types which the system, structure, mechanism, or machine has assumed; point out the advantages and disadvantages of each type, and select the one which seems best suited to the circumstances. For instance, in the case of an alarm system for a railway crossing, describe the automatic devices which are used; explain the merits and defects of each device, and then choose the one—appealing to the eye or to the ear—which is best adapted to the situation. Is the crossing such that a driver is likely to come upon it suddenly without noticing a danger sign? Is it such that a bell is not likely to be heard distinctly? Finally, is traffic sufficiently heavy to justify the maintenance of a guard? Questions like these must be asked and answered in every case.

Systems.—Alarm; canal; control; drainage; filing; fire prevention; heating; highway; illumination; irrigation; notation; railway; rapid transit; refrigeration; reproduction; sewerage; signal; telephone; ventilation; water supply.

Structures.—Arches; bridges; bungalows; buttresses; canal locks; chutes; cold storage plants; culverts; dams; dry docks; filter plants;

[1] Reprinted by permission of the American Society of Civil Engineers.

foundations; kilns; nurseries; piers; reservoirs; shafts; silos; smelters; weirs.

MECHANISMS.—Bells; bolts; cabinets; compasses; derricks; drills; gears; indicators; keys; levels; levers; motors; pumps; roofs; slide rules; stopers; torpedoes; trusses; valves; windows.

MACHINES.—Binders; churns; concrete mixers; crushers; cultivators; drill presses; lathes; milling machines; paper-making machines; pasteurizers; reapers; rippers; rock-breakers; separators; shapers; stamping machines; strippers; turret machines; typesetting machines; vanners.

Historical Review.—When a report marks a distinct advance in design, a review of previous developments may be necessary. This review is comparable to that in the introduction to a research report. It is a kind of historical sketch in which the stages in the process of evolution are cited in chronological order. Such a sketch is helpful in explaining the character of the design and in emphasizing the originality of the designer.

Factors Governing the Design.—A mere study of the reasons which have led to the selection or invention of a particular type of system, structure, mechanism, or machine is not sufficient. To enable a client to understand the singularities of the type selected, it is necessary to enumerate the factors governing the design itself. These factors may be matters of location, material, etc. Whatever this character, the ideal must be subordinated to reality.

For instance, the design of a levee for flood-control will be conditioned by economic considerations and property-values. In *The Improvement of Milk River,* existing irrigation systems altered somewhat the simplest type:

(5)

LEVEE DESIGN

197. As stated in paragraph 189, it is of course impracticable to provide protection for the entire area located within the limits of the levee system. In order to provide the necessary floodway area the set-back of the levees must be such as to leave a considerable portion of the valley unprotected. The set-back and height of

levees are mutually dependent functions of each other. Either the levees may be low and far apart, or they can be made higher and closer together. The proper set-back and height is largely an economic question. The best solution is that which sacrifices as little land as possible to the floodway between levees or between the levee and high ground on the opposite bank of the river without increasing the height and cost of the levees. In the case of the levee units in the Milk River Basin the purely economic considerations had to be altered considerably because of existing irrigation structures. The alignment of the levees was maintained as straight as possible and no set-back less than 200 feet from the river bank was used. These provisions are necessary to eliminate danger of the levees being undermined by caving banks and to reduce to a minimum the probability of erosive action of cross currents during high-flood stages. As far as possible advantage was taken of all ridges and higher ground, and all sloughs and shallow lakes were avoided.

200. The standard levee cross-section adopted provides for a slope of 3 to 1 on the land side, a crown of 6 feet, a 4- by 6-foot muck ditch along the center line of levee, a slope of 2½ to 1 on the river side, and a berm of not less than 40 feet between the toe of the levee slope and the edge of the borrow pit. Borrow pits are 1 to 1, to a depth of 5 feet from the level of the berm, thence with a 5-to-1 slope away from the levee, to a maximum depth not to exceed 15 feet. The plan also provides for borrow pit traverses 15 feet wide at intervals of at least 500 feet, to prevent a current along the levee. For levees over 18 feet in height the adopted cross section provides for a 10-foot banquette on the land side of the levee. A 2-foot freeboard is provided above the computed profile of the adopted flood, which provides a factor of safety of from 31 to 43 percent. In addition there is a factor of safety in the discharges computed for the adopted flood.

Here ideal economic considerations were abandoned in order to prepare a design that would meet the peculiar local factors encountered.

Similarly, the plan of a machine for washing ore will be modified by the character of the deposit to be treated. An example is to be found in *A New Machine for Concentrating Minnesota Wash Ores:*

(6)

The important facts shown in the screen analysis are: (1) the amount of low-grade material passing a 100-mesh screen, and (2) the high iron content of the material coarser than 100-mesh. The concentrating process consists in washing out the fine low-grade material from the ore, thereby producing a high-grade concentrate. Such an ore as represented by the above screen analysis can be washed and will produce a concentrate assaying 58 per cent iron, representing 68 per cent of the weight of the original material and containing 87 per cent of the total iron.

There is a very large amount of wash ore in Minnesota, but it does not always occur in large ore bodies. It also frequently happens that there is a certain amount of coarse silica in the ore material that cannot be washed out by the standard concentrating process. Such ore produces a low-grade concentrate which is of doubtful value. In cases where the body of wash ore is small, or the concentrate which may be produced is low grade, it is often impossible to realize a profit after paying the cost of installing and operating a standard washing plant.

Here, as often happens, the reasons prompting the selection of a particular type are combined with those which dominate the design. A fusion of this kind, however, generally lacks the definiteness of the treatment exemplified above.

Principles Underlying the Design.—The phases of the construction report already discussed are largely introductory. They are echoes of the office instead of the drawing-room. The routine of design, so far as it is reflected in the report, has still to be considered. The skilled designer utilizes not only his own experience but also that of others. In all probability, the way in which to proceed in a particular case has already been charted. Even though an architect or an engineer may pride himself upon his originality, he cannot work efficiently without consulting those who are recognized as authorities. Without the aid which they can give him, he is likely to make many a false start. There are always certain principles, established by practice, which are fundamental. If these are necessary to an understanding of the details of design and construction, they ought to be mentioned in the text. When they are generally familiar, a reference to the names by which

they are known will ordinarily be sufficient. When these principles are not generally familiar, they must be explained at length.

An explanation of the principles embodied in a new design for an instrument to detect the presence of gas in the atmosphere is presented (pages 811-825) in S. S. Tompkins' report, "Gas Detection Instruments," *Proceedings* of the American Gas Association for 1932, from which the following extracts are taken:

(7)

In 1878 E. H. Liveing described an indicator for detecting very small quantities of flammable gas and for estimating the proportion present. The Liveing indicator depended upon the principle that an electrically heated platinum wire, in contact with an atmosphere containing methane, glows more brightly than a similar wire heated in pure air, the difference in luminosity being proportional to the amount of methane present. The Martienssen detector of the present day operates upon a similar principle, the presence and approximate percentage of methane being shown by its effect upon the color or brightness of an electrically heated filament consisting of two legs of platinum alloy wire extending from terminals to a loop whose center has a coating of palladium salts.

In 1894, a U. S. Patent was granted to B. C. Tilghman disclosing a type of gas detector that has come to be known as the hot wire type of combustible gas indicator, many modifications of which have appeared commercially within the past few years and have been adapted for use in many fields. The principle of this detector, as described in the Specification forming a part of the Tilghman patent, is that the burning of a combustible gas on the surface of an electrically heated metallic filament causes an increase in its electrical resistance, which is proportional to the amount of combustible present and which may be conveniently measured by means of a Wheatstone bridge.

It will be noted that the principle of the Tilghman detector is very similar to that of the Liveing indicator, differing only in measuring the increase in the electrical resistance of a hot wire in contact with the atmosphere under test instead of the increase in luminosity. Several indicators now on the market utilize a further

modification of this principle, measuring the increase in the temperature of the hot wire rather than its increase in luminosity or electrical resistance.

DEVELOPMENT OF A GAS INDICATOR HAVING GENERAL UTILITY. —The individual limitations of the gas detection instruments previously described led the company with which the writer is connected to undertake the development of a combination of detection instruments which would indicate whether an atmosphere is safe for entry, whether it contains combustible gases in concentration presenting an explosive hazard, whether combustible gases if present are the product of gas manufacturing processes, and at the same time fulfil the practical requirements as to weight, portability, safety and simplicity of operation. The result has been a combination of a carbon monoxide detector, a combustible gas indicator of the hot wire type, and a wick-type flame safety lamp of special design. Provision is made for aspirating the atmosphere to be tested from its source, and the detection apparatus is fitted with adequate flame arrestors to prevent propagation of flame to the main body of the atmosphere.[2]

Calculations Required.—The principles on which any design is based are usually established by means of a number of calculations. There are few designs in which such calculations are not necessary. How far they should be included in the text is a difficult question. Since the layman is seldom competent to analyze them, they certainly should not appear in full. On the other hand, the results of these studies are often quite as important as the theories which have been discussed. They, too, are bases of the design. A sound method of procedure, therefore, is to include in the text a summary of the conclusions, placing in the appendix, where they can be examined by experts to whom they may be submitted for verification, the solutions that are too complex for any but the specialist.

The form sanctioned by usage is illustrated by "Calculations for a 2,500 KV-A Three-Phase Salient Pole Generator," by Henry M. Hobart, Consulting Engineer, General Electric Company, in *Design of Polyphase Generators and Motors.*[3]

[2] Reprinted by permission of the American Gas Association.
[3] Reprinted by permission of the publishers, The McGraw-Hill Book Company.

(8)

THE NUMBER OF POLES.—Since the machine is driven at a speed of

$$\left(\frac{375}{60} =\right) 6.25 \text{ revolutions per second,}$$

and since the required periodicity is 25 cycles per second, it follows that we must arrange for:

$$\left(\frac{25}{6.25} =\right) 4.0 \text{ cycles per revolution}$$

consequently we must provide four *pairs* of poles, or $(2 \times 4 =)$ 8 poles.

Denoting by P the number of poles, by R the speed in revolutions per minute, and by $\sim$ the periodicity in cycles per second, we have the formula:

$$P = \frac{120\sim}{R}$$

In this treatise the power factor will be denoted by G. Since for our machine the rated load is 2,500 kv-a for $G = 0.90$, we may also say that the design is for a rated output of $(0.90 \times 2{,}500 =)$ 2,250 kw. at a power factor of 0.90.

So many alternators have been built and analyzed that the design of a machine for any particular rating is no longer a matter which should be undertaken without any reference to accumulated experience. From experience with many machines, designers have arrived at data from which they can obtain in advance some rough idea of the proportions which will be most appropriate. It is not to be concluded that the designing of a machine by reference to these data is a matter of mere routine copying. On the contrary, even by making use of all the data available, there is ample opportunity for the exercise of judgment and originality in arriving at the particular design required.

If there is a series of calculations, a type problem only may be developed.

Preliminary Tests.—The final paragraph has been included in the last quotation because of the light which it throws upon the steps which must precede the preparation of the report.

Though it is true that every design, however revolutionary it may seem, is dependent upon previous developments, there is always room for originality even if the problem in hand appears distinctly conventional. In the design of mechanisms and machines, originality is usually expressed experimentally. In addition to scrutinizing the fundamental theories and completing the calculations necessary, the engineer often finds it advisable to undertake a series of tests to verify these theories and calculations or to establish new principles and methods of attack. In a field like aeronautics, in which practice outruns theory, experiments are ordinarily conclusive. Many of the designs proposed by the National Advisory Committee for Aeronautics and the Royal Air Force Establishment are based entirely upon tests extending, in some instances, over several months.

Since similar tests have been described in Chapter 11, it is unnecessary to explain the manner in which they are ordinarily reported. When they are reviewed at length, there are references to

1. Purpose
2. Material
3. Apparatus
4. Procedure
5. Result

Seldom, however, are these points of equal interest to the layman. What has been said regarding calculations applies with equal force to tests. As a rule, only the results can properly be included in the text. Other data will be reserved for the appendix. There are times, however, when it is a distinct advantage to refer to the character and scope of the experimentation.

Excellent descriptions of the kinds of tests common in the field of engineering are to be found in the *Final Report on the Bridge over the Delaware River Connecting Philadelphia, Pennsylvania, and Camden, New Jersey,* and the illuminating series of papers on the George Washington Bridge published in the *Transactions* of the American Society of Civil Engineers for 1933. These publications describe numerous tests on materials, models, and sections of the finished structures.

Plan Followed in the Design.—The last three topics—theories, calculations, and tests—are all preliminary. The problems associated with them must be considered before the design itself can be begun. In interpreting the details, an indication of the plan adopted is of vital importance. As illustrated by the following passage, the aim is to portray the main features of the scheme presented. The result is a kind of panorama of the system, structure, mechanism, or machine to be constructed. In a report on a system or structure, stress will fall upon location; in a report on a mechanism or machine, it will fall upon operation.

From "Proposed Improvement of Cape Cod Canal," by E. C. Harwood, Esq., Captain, Corps of Engineers, *Transactions* of the American Society of Civil Engineers, Vol. 101, pp. 1450-1451 (1936).

(9)

THE PROBLEM OF IMPROVING THE CANAL

Hearings held in 1934 and earlier, as well as repeated contacts with masters of ships and pilots by officers and civilian employees on duty in Boston and at the canal, make it possible to state the nature of the improvement desired by interests using the canal. Briefly, it is that the channel should be deepened and widened to permit two-way traffic and that the width should be sufficient to remove the risk of being caught during a falling tide with the bow of the ship on one bank and the stern on the other; or, that the canal should be widened somewhat so as to permit two-way traffic and that locks should be installed in order to still the currents, thereby removing the risk of stranding a vessel crosswise in the channel. . . .

The project dimensions on which the estimates are based are a depth of 32 ft. and widths of 250 ft. and 540 ft. for the lock and open canal, respectively. This particular depth was selected because it will accommodate practically all the vessels now entering and leaving the Port of Boston which may be expected to use an improved canal. Taking into consideration the number of ships of the different drafts and their cargo capacity, it is found that this is the economic depth. That such is the case is readily seen by reference to Fig. 4 [omitted] where the cargo-carrying capacity of the vessels entering and leaving Boston Harbor is shown for

each of several drafts. (There should be at least 4 ft. of over-depth to allow for minus tides, for "squat" in a restricted channel, and for the fact that the channel bottom will not be soft material but will be thickly strewn with boulders.) It is apparent that a depth of 30 ft. would not be sufficient for the relatively large volume of cargo carried in vessels having a draft of from 26 to 28 ft., whereas 32 ft. would be deep enough for these ships. The additional 2 ft. of depth gives a great increase in cargo-passage capacity. On the other hand, it is equally apparent that a further increase in depth—say, to 35 ft.—would result in only a small increase in cargo-passage capacity and that it would not be economically justified at this time. A width of 540 ft. is considered desirable for the open canal for reasons already mentioned, and in order that the further deepening to 40 ft. at some future time may be made, giving a bottom width of 500 ft., without disturbing the side slopes and bank protection.[4]

Details of the Design.—The details of the design are, of course, the most important part of the report. The paragraphs dealing with them are interpretations of, and commentaries on, the plans proposed. For convenience, therefore, these sections are often numbered to facilitate coincident reference to the maps and drawings which accompany them. In general, they are arranged according to their order in space or procedure.

In his paper, "The George Washington Bridge: General Conception," already mentioned, O. H. Ammann devotes several sections to a discussion of the details of the design. Since at the time the paper was written the bridge was open for traffic, the tenses, which, in construction reports, would be some form of the future, are here partly in the past. The second paragraph, however, illustrates the proper tenses for a construction report. Especially interesting are the contrasts and comparisons which Mr. Ammann uses in his explanation:

(10)

THE FLOOR STRUCTURE. . . .

Consideration of the traffic requirements, the conception of the stiffening system, and the arrangement of the four cables in pairs on each side of the floor, led to a structurally and statically simple arrangement of the floor system suspended from the cables.

[4] Reprinted by permission of the American Society of Civil Engineers.

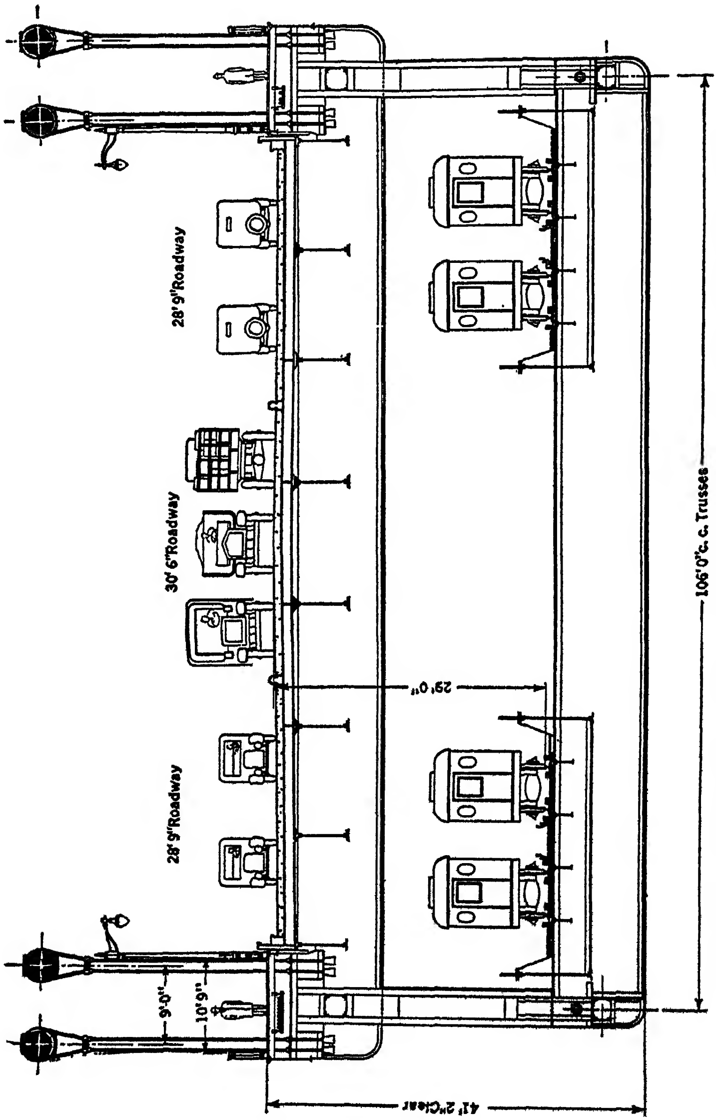


Figure 20. Typical Cross-Section of Double-Deck Floor, George Washington Bridge
(From *Transactions* of the American Society of Civil Engineers, Vol. 97)

An upper floor is designed to accommodate at least eight lanes of vehicular traffic. Beneath it, and connected to it by rigid floor frames, is a lower deck designed to carry at least four tracks for heavy rapid transit traffic; or this deck may be utilized for additional vehicular lanes in case that should ever become necessary and desirable.

A shallow stiffening truss with chords only 29 ft. apart is placed on each side of the floor system in the plane of the cables and suspenders. A single, relatively flexible, horizontal wind truss is arranged in the plane of the upper deck, the upper chords of the stiffening trusses forming the chords of this horizontal wind truss. The wind forces acting on the lower deck are transmitted to this wind truss through the rigid floor frames.

In a preliminary design the floor frame was conceived as an inverted U, with brackets cantilevering out from the vertical posts on both sides. This arrangement was eventually abandoned in favor of the somewhat simpler and only slightly more expensive closed frame carrying all tracks inside the posts. This entire floor structure is designed so that the lower deck, together with the webs and bottom chords of the stiffening trusses, could be omitted initially and added in a very simple manner at any time in the future when necessity therefor will arise.

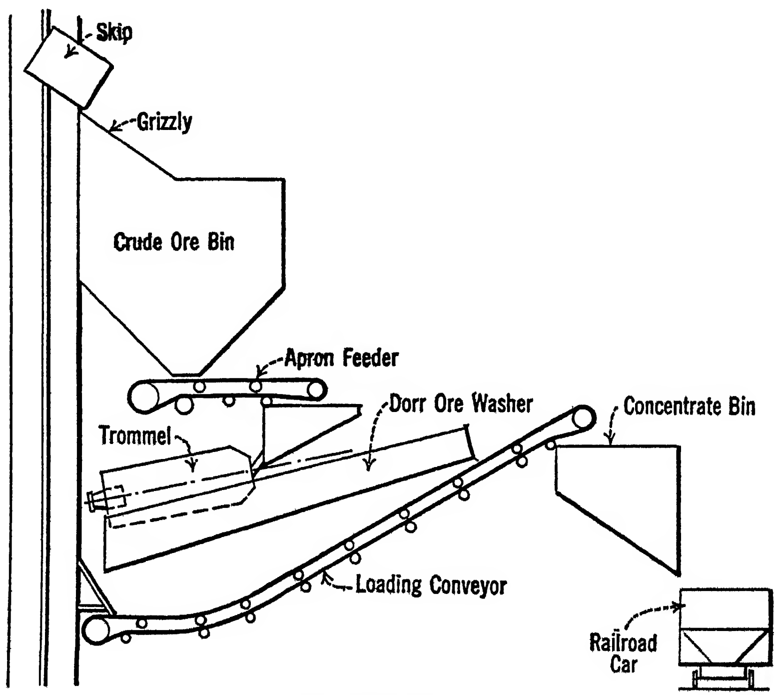
The vertical stiffening trusses have a depth of 29 ft. throughout, which is only one-one-hundred-twentieth of the central span. This compares with the corresponding ratio of one-sixty-third in the Delaware River Bridge, which has a center span of 1750 ft.; with one-sixtieth in the Manhattan Bridge, which has spans of 1470 ft.; and with one-sixty-third of the central span of 1630 ft. of the Bear Mountain Bridge, these being the three longest modern suspension spans in existence, or in course of construction, at the time the writer made the first studies. The first two, like the George Washington Bridge, are designed to carry highway and electric rail passenger traffic, while the Bear Mountain Bridge carries highway traffic only.

An excellent illustration of a corresponding passage from a report on the design of a mechanism or machine occurs in *A New Machine for Concentrating Minnesota Wash Ores:*

(11)

In order to show the simplicity of plant construction which may be taken advantage of by the use of the new ore-washing machine,

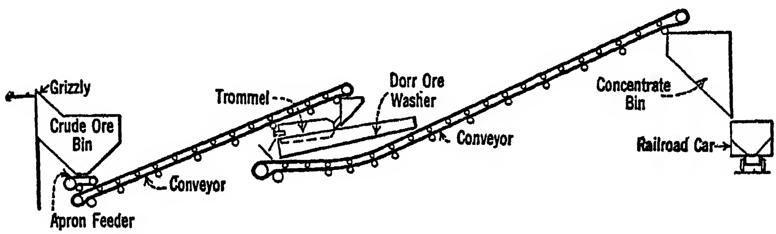
a few mill flow sheets have been prepared. Flow Sheet No. 1 shows a possible application to an underground deposit of ordinary wash ore. The whole plant is located in the head frame, and the skip dumps the ore over a grizzly into the hopper above the washing machine. A steel apron feeder is used under this hopper in order to maintain a uniform rate of feed to the plant. This feeder delivers the ore to the trommel of the washer, and the concentrate from the machine falls onto a conveyor belt located under the classifier tank. The coarse material falls on the belt first, thus making hand picking possible.



Flow Sheet No. 1

A small pocket is provided for the storage of concentrate in order to permit shifting cars without closing down the plant. If the head room is cramped, however, this pocket may be eliminated as it is entirely possible to shut this plant down and start it again at a moment's notice. One 25-horsepower motor will furnish ample power for the operation of the entire plant exclusive of the water

pumps and the hoist. The plant will have a capacity of 1,000 tons of concentrate per day and will require a supply of from 500 to 800 gallons of water per minute. It is estimated that this plant, including the head frame, could be built at the present time for from $20,000 to $40,000.



Flow Sheet No. 2

Flow Sheet No. 2 shows a possible installation in connection with an open-pit mine of good wash ore. The ore is dumped from the pit cars over a grizzly and into a bin from which a steel apron feeder delivers it, at a constant feed rate, to the incline belt conveyor. This conveyor puts the ore directly into the hopper of the washing machine, and a second incline conveyor carries the concentrate to the loading pocket. A 50-horsepower motor would operate this plant, and the tonnage handled and water required would be the same as given for the previous flow sheet. A plant of this design could probably be built for approximately $50,000.

In this case, the features of the design are enumerated in the order in which they are employed in the process of concentration.

Methods Proposed.—Since the value of a report depends upon the practicability of the design proposed, an explanation of the methods of construction that may be employed to advantage is almost as essential as a description of the details themselves. Where the methods suggested are new or unusual, an exposition of this character is particularly important. Even if they are not especially new or unusual, a note on their advantages and disadvantages is never out of place. A typical passage follows.

From *Report of the Transit Commissioner, City of Philadelphia:*

(12)

METHODS OF SUBWAY CONSTRUCTION

The construction of shallow subways under public streets necessitates in most cases the use of what is known as the open-cut method of construction, in which a section of the pavement is removed and all material is excavated in open cut. The surface of the street in general is partially restored by temporary planking or one-half is opened at once, except in the business district, and as little obstruction as possible is created in the use of the streets. In deep subways, or tunnels, the surface of the street is not disturbed, the excavation being made at sufficient depth to go below all existing sub-surface structures. Where the material is clay, as in London, or where it is sound rock, this method of constructing tunnels is sometimes to be preferred. The objections to these deep tunnels, however, are the difficulties in ventilating and in obtaining access to them by passengers. This latter feature is so serious an objection that in London it has been necessary to install elevators at some of the deeper stations.

The cost of construction under certain circumstances does not vary greatly between the two methods. In New York along Lexington Avenue, at present, on account of the width of the street being insufficient for 4 tracks at one level, 2 tracks are being constructed as a shallow subway by the open-cut method and 2 tracks below are being constructed by tunneling. In the subways of Paris both methods have been used to some extent, but the greater portion of the Paris lines has been built by the open-cut method. In the cost estimate for the Philadelphia subways it has been assumed that the open-cut method will be used almost exclusively, the exception being at some points where the depth is great and at points where it is necessary to pass under structures that cannot be well underpinned otherwise.

A comparative study of this kind has become almost a fixture. In the light of experience, the merits of any procedure can usually be established with a fair degree of accuracy. As in the report cited above, the cost—a subject to be considered shortly—is often as dependent upon the methods of construction as upon the nature of the design.

Materials Available.—Fully as important as the methods applicable to a particular problem are the materials available for

construction. These must always be indicated. Occasionally it may be sufficient to refer to codes issued by local authorities or to specifications published by technical societies. Often, however, questions of supply, adaptability, and price cannot be avoided.

In a paper, "Luminescent Materials for Cathode-Ray Tubes," *Proceedings* of the Institute of Radio Engineers for 1935, T. B. Perkins and H. W. Kaufmann, of the R. C. A. Manufacturing Company, deal (pages 1324-1333) with the characteristics and advantages of various phosphorus or luminescent materials employed in cathode-ray tube screens. A noteworthy feature of the report is the clearness with which the authors distinguish between the special characteristics of the three types of materials studied:

(13)

Of the many materials used for cathode-ray tube screens, the one probably best known is a silicate, synthetic willemite. This is crystalline zinc orthosilicate containing a small proportion of manganese. It is fairly typical of the silicates in particular, and of the so-called "activated" luminescent materials in general: the pure base material (zinc orthosilicate) is not luminescent, but becomes so upon the inclusion in its crystal structure of a small amount of some foreign substance (manganese, in this case), which is called the activator. There is an optimum concentration of the activator for maximum light production efficiency; a large excess of activator produces a material which is completely insensitive to cathode rays. The optimum concentration of a given activator varies for different crystalline bases. Silicates may be formed by heating together suitable proportions of a metal oxide, an oxide of the activator, silica, and a flux. These preparations are usually quite stable and not easily harmed by heating in any atmosphere. A screen using one preparation of this class is identified for convenient reference in this paper as No. 1 phosphor.

A second group of luminescent materials may be classified as sulphides. The term, No. 2 phosphor, is used to identify an example of this type. The sulphides of various bivalent metals can be made luminescent by the presence of activators in the same way as can the silicates; copper is one of the most effective activators. Its optimum concentration, however, is so very small that ordinary

"chemically pure" sulphide samples may contain enough copper to suppress the luminescence. The process of manufacture is, therefore, begun by purifying a soluble salt of the metal whose sulphide is to be prepared; this is done to remove the excess of copper and certain heavy metals, such as iron and lead, which render the sulphide non-luminescent. The sulphide may be precipitated from the purified solution. This preparation is mixed with suitable fluxes, sufficient activator is added to bring the total percentage up to the optimum, and the mixture is fused in a controlled atmosphere to prevent oxidation of the sulphide. The product is crystalline and usually more resistant to chemical attack than the corresponding sulphide in the amorphous state.

There is a third group of luminescent materials, including certain tungstates and molybdates, which are generally considered to be self-activated and require the presence of no impurity to produce luminescence. The No. 5 phosphor is an example of this class. It should be remarked that recent evidence indicates that activation of the tungstates may be due to exceedingly minute traces of lead. When luminescent materials were first investigated systematically, the number classified as pure, "self-activated" substances was very large. With later and improved analytical methods, many of these were found to contain traces of foreign substances which were shown to be activators. It is, therefore, not surprising that uncertainty concerning the activation of the tungstates should still exist. The tungstates and molybdates may be formed by the union, at high temperature, of a metal oxide with tungstic or molybdic acid. They are quite stable chemically and certain of them appear to be capable of giving almost unlimited life in a cathode-ray tube.

Many oxides, both bivalent and trivalent, can be activated by some of the rare earth elements and by certain other metals, for example, chromium. A well-known example of this very broad class is the ruby, which is aluminum oxide activated by chromium; its luminescence is of the beautiful red color for which the gem is so highly prized.

The No. 1 phosphor, used in RCA tubes numbers 903, 904, 905, and 906, produces a general purpose screen having high candle power per watt, brilliant green color, good photographic qualities when verichrome or panchromatic type films are used and a medium persistence sufficient to aid the eye in eliminating flicker when determining wave form of certain low-frequency phenomena. The No. 2 phosphor is a long persistence screen whose special

quality is its ability to display the trace of the electron beam's path long after it has left the screen. This screen, therefore, finds a wide field where ordinarily the electron beam travels too slowly for the persistence of the eye to visualize the shape of the wave formed by the trace or too fast for the eye to comprehend the detail of phenomena. A short persistence screen is found in the No. 5 phosphor, which is used in cathode-ray tubes, RCA-907 and RCA-908. This screen is well adopted to all photographic work because its spectral distribution lies in the blue and ultra-violet and because its especially short persistence allows the photographing of high-frequency phenomena on film moving at high speed.[5]

The technique used in these paragraphs is applicable to the discussion of materials in any construction report. Each of the types available is discussed independently, and the types are then compared. In addition to the factor of usefulness, most construction reports also treat the element of cost, which was not a consideration here. Likewise, aesthetic considerations or those of safety may occasionally help to dictate the kinds of materials used. Thus, the massive masonry towers which give to the Brooklyn Bridge its majestic beauty have been discarded by the designers of recent suspension bridges in favor of cheaper but less architecturally effective steels towers. Mr. Ammann's comment in the paper already referred to is instructive:

(14)

Although no definite detail plans have been developed for the encasement, the towers have been the subject of extended architectural study. In their latest development in that respect (1931) they are illustrated in Fig. 22 [omitted].

Since the steel tower frame is proportioned to carry the entire ultimate load for which the bridge is designed, the future addition of the concrete encasement, or possibly of a mere shell surrounding the steel frame, as has been suggested, or a combination of both, becomes essentially an æsthetic and architectural question. Before taking any action in this matter, the Port Authority will undoubtedly want to scan public opinion carefully, and particularly give due regard to the attitude of those civic and governmental organizations that are interested in the æsthetic development of the community and the preservation of the beauty of the landscape.

[5] Reprinted by permission of the Institute of Radio Engineers.

The writer, who has conceived and is primarily responsible for the type and general form of the design, considers the steel towers as they stand to represent as good a design as may be produced by a slender steel bent, and that they lend the entire structure a much more satisfactory appearance than he (and perhaps anyone connected with the design) had anticipated. Nevertheless, he believes that the appearance of the towers would be materially enhanced by an encasement with an architectural treatment, such as that developed by the architect, Mr. Cass Gilbert, as illustrated in Fig. 22 [omitted].

The writer is not impressed by the criticism, based solely on theoretical and utilitarian grounds, that encasement would constitute a camouflage which would hide the true structure and its function. The covering of the steel frames does not alter or deny their purpose any more than the exterior walls and architectural trimmings destroy the function of the hidden steel skeleton of a modern skyscraper, except to the uninitated.

Camouflage in this sense would condemn many of the creations in private and public life. It is an essential manifestation of civilization and is not incompatible with sincerity and honesty of endeavor, because an essential part of human effort is to create an æsthetic atmosphere, the value of which cannot be expressed in economic terms. This is evidenced in the craving for beautiful homes and public institutions which yields only to the limits of available means. Why should not a supreme effort be made in that respect in engineering structures, especially those which are viewed daily by thousands or millions of people?

Nevertheless, if the encasement should not be built the writer will be satisfied that the effort to produce a massive structure has not been without fruits. The steel tower as it stands owes its good appearance largely to its sturdy proportions and the well-balanced distribution of steel in the columns and bracing.

At its present stage (1932) the top of the steel tower (Fig. 23) [omitted] requires certain finishing additions. The cable bearings must be housed. It is also recognized that the tops of the towers more than 600 ft. above the water, which offer splendid views of the landscape for many miles all around, should be made accessible to the public by the provision of suitable elevators and protected observation platforms. . . .[6]

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[6] Reprinted by permission of the American Society of Civil Engineers.

Cost of Construction.—After methods and materials have been determined, an estimate of the cost of construction should not be difficult. As a rule this estimate, which is usually arranged in tabular form, with reference to the sources of the data upon which it is based, is merely an explanation and interpretation of various tables. On occasion these follow the text; at times they may be placed in an appendix. For example, in the *Report of the Engineering Board of Review of the Sanitary District of Chicago . . .* (Boston, 1925) the volume (Part III, Appendix I) entitled "Sewage Disposal" presents explanations and tables concurrently. The following extract, from which tables have been omitted, will illustrate the style:

(15)

Cost Estimates.—In the tables 55 to 67 [omitted] are given in detail, estimates of construction cost of the several treatment projects. Tables 55 to 58 [omitted] show the estimates of cost of Imhoff tanks, sludge drying beds, trickling filters and secondary settling tanks per million gallons per day of sewage treated. In the case of trickling filters, provision has not been made for flooding the beds, as the breeding of flies can be controlled by other means.

Tables 59 to 61 [omitted] show the estimates of cost of additions to the Des Plaines, Calumet and North Side sewage treatment plants. The additions to the Des Plains and North Side plants have been based largely on the cost of the work under construction at the North Side plant. The additions to the Calumet plant, including the trickling filter plant, have been estimated on the basis of the costs assumed for the Southwest Side plant. The estimates include 15 per cent allowance for engineering and contingencies.

Under the project for miscellaneous treatment plants and sewers, several small plants have been estimated (Table 67) [omitted]. These plants are to serve an estimated population of about 79,000. The human population to be served by miscellaneous treatment in 1945 is estimated at 298,000. Therefore a population of 219,000 is to be provided for by plants not specifically mentioned. It has been assumed that such plants including collecting or intercepting sewers will cost about $35 per capita, amounting to $7,660,000 or, say, $8,000,000.

Cost of Ultimate Future Treatment.—The cost of providing trickling filters at the West Side and Southwest Side treatment plants adequate for the year 1955, is shown in Table 64 [omitted]

and, including enlargement of pumping stations and Imhoff tank plants, will amount to $19,713,000 and $16,063,000, respectively, making a total estimated cost of $35,776,000.

Maintenance and Operation Estimates.—Table 68 [omitted] gives the estimated cost of maintenance and operation of the sewers and sewage treatment plants for each of the major treatment projects subdivided in items of electric power, labor, supplies and renewals and repairs.

The costs of electric power for the Stockyards, Des Plaines and North Side plants are high because of the power required for compressing large volumes of air for the activated sludge process, and also, in the cases of the first two named, for sludge dewatering equipment. The Stockyards wastes require a much larger volume of air per gallon than the Des Plaines sewage.

The estimated cost of labor per million gallons at the Des Plaines plant is high, compared with the North Side activated sludge plant, because of the experimental work carried on at the plant and the dewatering and preparation of dried sludge for sale as fertilizer. On account of the small size of the plant this work is relatively expensive per million gallons and per capita.

The Stockyards plant will require a large labor force to operate the sludge dewatering equipment. The labor cost for the Corn Products plant will also be relatively high per million gallons for the same reason, even though the treatment of the waste be by trickling filters. The North Side activated sludge plant will require somewhat less labor, relatively, because there is no sludge dewatering equipment.

Renewals and repairs for the Des Plaines, Stockyards and Corn Products plants have been computed at 2 per cent of the construction cost, because of the machinery and other equipment involved. The North Side plant will have much less mechanical equipment. The Corn Products plant will have mechanical sludge removing apparatus as well as sludge dewatering equipment. The item of renewals and repairs, in the case of the Calumet plant, has been taken at 1 per cent instead of 1.36 per cent or 1.35 per cent used in the case of the West Side and Southwest Side plants, respectively, because of the relatively high construction cost of the Calumet plant, which was built during the period of high prices following the war. The estimates of the cost of the Calumet plant do not include the operation of the trickling filter plant, although the total cost of construction given in Table 67 [omitted] does include the filters. If the cost of operation of the trickling filter plant,

including the additional pumping, is added, the operation cost for the year 1945 would be increased by about $43,000.

In the case of the Des Plaines and Stockyards plants a credit from the sale of dried sludge has been allowed at the rate of $10 per ton. In all of the estimates electric power has been assumed to cost at the rate of 1 cent per kilowatt hour.

Studies in Operation.—At present, it is customary to supplement the estimates of cost by studies in operation. Ordinarily the tendencies established by these studies are projected by means of charts. In the case of a rapid transit system, for example, the annual increase in the load may be anticipated by a review of the increases in population during the previous decade. In the case of an apartment house, fluctuations in the value of neighboring properties may be useful in plotting the curve of return. In both cases, graphic devices will probably be employed to complete the exposition.

A section estimating the ultimate cost of a project as a whole is a common feature of construction reports. Sometimes, also, as in the following illustration, the results of operation and maintenance are also predicted. Occasionally, if the project is intended to liquidate itself, an estimate of revenue is included. *The Tentative Report on the Kill Van Kull Bridge* (New York, 1927), although preliminary in its nature and content, illustrates the method of presenting probable revenue:

(16)

In order to determine the economic practicability of constructing a bridge across the Kill van Kull, which is to be operated and maintained from tolls, the Staff of The Port of New York Authority undertook an intensive analysis of the traffic. Considerable data were at hand from the studies for the two Arthur Kill bridges, in 1924, when inspectors were placed upon the Perth Amboy, Carteret, Elizabeth, Bayonne, and Bay Ridge ferries to obtain the origin and destination of vehicles. A special force of inspectors was placed on the Bayonne, Whitehall, 39th Street (Brooklyn) and Bay Ridge ferries again in 1926, to obtain additional information.

From information supplied by ferry and railroad companies and the original data collected by the Staff, as to the origin and destination of vehicles, forecasts were made. From these data tentative

figures have been prepared, which sufficiently indicate the economic practicability of constructing a bridge over the Kill van Kull. Final figures are in course of preparation. The tentative estimates of traffic are as follows:

ESTIMATES OF TRAFFIC OVER THE BAYONNE BRIDGE

Year	Vehicles	Busses	Vehicles plus Busses	Passengers in Vehicles	Passengers in Busses	Pedestrians
1932	1,261,500	298,500	1,560,000	1,892,300	5,970,000	113,500
1937	2,248,100	531,900	2,780,000	3,372,200	10,638,000	158,500
1942	3,800,700	899,300	4,700,000	5,701,100	17,986,000	223,800
1947	5,717,200	1,352,800	7,070,000	8,575,800	27,056,000	308,900

These tentative figures were used to determine approximate gross revenues. A study of the existing ferry rates disclosed that an average rate of 60 cents for vehicles, except for certain classes of through traffic, 5 cents for passengers in vehicles, 75 cents for buses, 5 cents for passengers in buses, and 5 cents for pedestrians were reasonable charges upon which to base the estimates.

Similar rates were used in estimating the following revenue and the percent of net operating income to estimated cost:

Year	Gross Revenue	Administrative Operation Maintenance	Net Operating Income Available for Interest and Amortization	Per Cent of Net Operating Income to Estimated Cost
1932	$1,253,450	$150,000	$1,103,450	6.90%
1937	2,231,350	200,000	2,031,350	12.70
1942	3,770,450	250,000	3,520,450	22.00
1947	5,670,200	250,000	5,420,200	33.88

It will be seen from the above tabulation that the net return upon the investment would be more than adequate to meet the interest on bonds.

Importance of the Appendix.—In most construction reports, even in those intended for the layman, the appendix is as important as the text. As already indicated, the appendix contains not only theories, calculations, experimental data, and tables of quantities and costs, but also the plans which have been described in the text. All these elements must be headed and numbered in an appropriate manner.

Legend.—The plans especially must be marked so carefully that they can be identified at any time by both expert and client. To guard against confusion, it is customary to place under the

border line at the lower right-hand corner of the page a legend corresponding in size with the drawing to which it refers. This legend contains references to

I. THE CLIENT OR EMPLOYER

The name of the client or employer for whom the report has been prepared.

II. DRAWING

1. The title, which is invariably printed in large letters.
2. The date, which is often significant. If the drawing has been altered in any way after the original date, this fact must be indicated.
3. The scale, as "100 feet to 1 inch." A graphical scale, used in case of reproduction, is generally added.

III. THE EXPERT OR EMPLOYEE

The name of the individual or firm responsible for the report. The draftsman's initials are often placed below.

Index.—If the report is especially intricate, an index may be added. As a rule, it is now omitted and the table of contents is made unnecessarily detailed and specific.

Outline of Data Contained in a Typical Construction Report.[7]—The phases of the construction report may therefore be summarized as follows:

I. PREFACE

1. Title Page
2. Table of Contents
3. Letter of Transmittal
   A. Characteristics of Design
   B. Estimates of Cost

[7] An excellent outline for a report on water supply will be found in H. E. Babbitt's *Water Supply Engineering* (New York, 1931). Similar outlines in specialized fields are available in the standard texts.

II. TEXT

1. Introduction
   - A. Object. A statement of the purpose of the design and the function of the system, structure, mechanism, or machine to be designed.
   - B. Scope
     - (a) General Considerations. The selection of a specific type of system, structure, mechanism, or machine. An historical review may be necessary.
     - (b) Particular Considerations. An exposition of the factors governing the design of the type selected.
2. Analysis
   - A. Theories. An explanation of the principles underlying the design.
   - B. Calculations. An interpretation of the computations required.
   - C. Tests. A review of the experiments needed to verify or to amplify the theories and calculations:
     - (a) Purpose
     - (b) Materials
     - (c) Apparatus
     - (d) Procedure
     - (e) Results
3. Design
   - A. Generalization. An indication of the order or direction of the design.
   - B. Particularization. A description of the details.
4. Construction
   - A. Methods. An exposition of those proposed.
   - B. Materials. A study of those available.
   - C. Estimates. A discussion of those listed in the appendix.
5. Comment. A glance into the future.

III. Supplement

1. Appendix
   - A. Premises
     - (a) Theories
     - (b) Calculations
     - (c) Tests
   - B. Plans
   - C. Estimates
2. Index.

Adaptation to the Specialist.—Though occasionally employed by architects and engineers in academic reports regarding systems, structures, mechanisms, and machines that have just been evolved, and are therefore unknown, the scheme outlined on pages 417ff is more generally employed in explanation of a design that appears suitable to a given situation. Reports of this character are prepared for specialists as well as for laymen. When they are submitted to other architects and engineers, who are able to interpret the plans for themselves, the preliminary exposition is relatively slight. References to types, for instance, may be superfluous. Under ordinary circumstances, also, familiarity with the theories that underlie the design may be assumed as a matter of course. On the other hand, calculations and conclusions from tests must be included. Though they are certain to be scrutinized with the utmost care, most space ought to be devoted to the factors governing the details of construction.

Alternate Projects.—So far, nothing has been said regarding alternate projects. Ordinarily the merits of a design are so obvious that, in a given case, no other type needs to be considered. At times, however, an expert may be confronted with a problem which can be solved in a number of ways. Each of the solutions possible may possess a unique feature which makes comparison, and hence choice, extremely difficult. In such circumstances, it is customary to include in the appendix of the report data which will enable a client to determine whether a detailed study of the other possibilities will be of interest to him. On rare occasions, when the ultimate decision is a matter of

taste, all information available is included in the text. As a rule, however, the text of a construction report is restricted to an exposition of the design which the writer feels is likely to be most satisfactory.

Exercise: A Construction Report.—Prepare a construction report upon one of the following topics, each of which can be covered in a relatively short time. Consider, so far as they are pertinent, the points mentioned in the outline on pages 417-419. For instance, in the case of a construction report upon an automobile body, discuss the advantages and disadvantages of the different types which are practicable and then select the type which is most suitable. Explain the factors—size of chassis, cost of equipment, etc.—that will determine the character of the design. Describe the details, the methods proposed, and the materials available. Choose a particular chassis—a Ford, for example—and fit it with a racing body made of odds and ends rescued from the wreck of a larger car.

An automobile body; a bookcase; a bridge over a small stream; a bungalow for a lot 25 x 100 feet; a cinder path; a clothes reel; a clothes chute for a small residence; a dark room; a drainage system for a farm; a fire alarm system for a school house with four floors; a filing system for a registrar's office; a foundation for a residence; a float; a grandstand for an athletic field; a heating system for a private garage; a highway system for an estate of 500 acres; an illuminating system for a residence; an irrigation system for a fruit ranch of 10 acres; a library table; a log cabin for a summer home; a pier for a summer cottage on a lake; a plan for a retail store; a private greenhouse; a radio set; a refrigeration system for a bungalow; a silo for a dairy farm of 100 acres; a sewerage system for a country estate; a score board for football; a sprinkler system for a department store; a street railway for a town of 5,000 people; a two-car garage; a telephone system for a hotel; a ventilation system for a moving picture theatre; a water supply system for a country house.

CHAPTER 17

EXPERIMENTAL RESEARCH REPORTS—PRELIMINARIES

Types of the Research Report.—The research report assumes three distinct forms—descriptive, theoretical, and experimental—determined by the material with which it deals and the point of view which it reflects. These forms correspond roughly with the epochs of civilization. In prehistoric times man, like a child, must have tried merely to identify the objects about him. Until the close of the Middle Ages, he was content, as a rule, to speculate regarding their relationship. Not until the Modern Era did he turn from theory to experiment. Today his attitude is objective, not subjective. Exactly similar has been the history of special fields. Materials and species of all kinds must first be described and catalogued. New mechanisms and machines, new ores and metals, and new fauna and flora are being constantly figured and classified. Reports of this character published yearly by universities, museums, government departments, and learned societies number thousands. Occasionally, also, writers are confronted with the task of interpreting ideas at which they have arrived through studying the relations existing among materials and species discovered, and usually described, by others. Under such circumstances, observation is entirely passive, and the report itself is a kind of argument. Instances occur in the work of Darwin and Einstein, both of whom have used as the bases of their generalizations facts educed by less daring thinkers. Their success has been due entirely to acuteness of perception and accuracy of thought. Although studies like those associated with the theories of evolution and relativity are not uncommon in certain mathematical associations and in various American universities, where they are assigned as academic exercises; and although the results are occasionally published by both agencies, they are few in number when compared with those dependent upon

laboratory practice. Because reports based on experimentation are of prime importance; because they illustrate all the problems of research, and because, historically, they represent the last of the three stages of development mentioned earlier in this paragraph, they will be considered first.

Origin of the Experimental Report.—In its experimental form, the research report has sprung from recent developments in science and industry. Through investigation the forces of nature have been subordinated to the needs of man; and through reports the results have been incorporated in the records of the race. As commercial laboratories increase in number and importance, research will doubtless be directed more definitely toward distinctly practical ends. Today much of it is immediately utilitarian. In the conquest of the material universe, however, scholars often deal with problems such as magnetism and selection that to the uninitiated seem trivial and inconsequential. Nevertheless, the spirit of adventure that prompts them is justified of itself. Truth is indivisible; and the utility of any investigation that enlarges the bounds of knowledge cannot be estimated by an absolute standard.

Subjects of the Experimental Report.—In general, the problems which scientists undertake to solve fall into a number of distinct classes dealing with properties, reactions, etc.; that is, they are studies in strength, elasticity, and resistance; immunity, responsiveness, and variation; or simplicity, economy, adaptability, etc. Such studies are current in all public and private laboratories: in those of government departments such as the Bureau of Standards and the Bureau of Mines; in those of state institutions such as Illinois and Wisconsin; in those of technical schools such as the Massachusetts Institute of Technology and the California Institute of Technology; in those of endowed universities such as Harvard and Chicago; in those of private foundations such as the Mellon and Rockefeller Institutes, and in those of corporations such as the Westinghouse and General Electric Companies.

First Step in an Investigation.—In the process of investigation, the first requirement—that treated in this chapter—is

familiarity with what has been accomplished in the field of research. It is a commonplace that civilization began with the alphabet. With that invention, achievement became permanent. The work of one generation remains as a foundation for that of the next. Of all that has happened from year to year, and of all that is happening from day to day, little can be learned except through literature. The primary source of knowledge for the experimental report is therefore not experience, as in the examination report, but reading. The first step is to discover through it what has been done. The routine is set forth with admirable clearness in the following passage from *Smoke Abatement:*

(1)

101.01. THE COMMITTEE'S REVIEW OF THE LITERATURE OF SMOKE ABATEMENT.—As an initial step in the development of its researches, the Committee has reviewed with care the published records of investigations relating to smoke abatement which have been made by scientific commissions and professional experts in this and other countries. It has translated a voluminous file of foreign documents. The various papers and reports which have thus been brought together may be assumed to present a world view of the history and progress of smoke abatement.* Any attempt to reduce this mass of material to the limits of a few pages presents great difficulties, but it is believed that the account which follows reflects with reasonable accuracy the important facts of the more extensive record and that it will serve to give a broad view of the general problem which confronts Chicago.

* Archives of the Committee, Vols. M1 to M5. For list of the authorities consulted, see Appendix, section 701.59, Bibliography.

Consultation of Authorities.—This extract illuminates the method to be followed. The review is based on authorities. Who, then, are they? How may they be consulted? Authorities are scholars and practitioners who are regarded as specialists; and they must be consulted indirectly, as a rule, through what they have written. What they have written may be discovered through the following sources:

1. CATALOGS.—These are two distinct classes: (a) Card catalogs of the libraries to which an investigator has access

through visit or correspondence. They are usually of the so-called "dictionary" type: that is, they are arranged alphabetically by author, by title, and by subject, under a single alphabet. The value of the catalog is determined by the amount of cross-indexing which it contains. Some of the older libraries also issue printed catalogs which are to be found in most reference rooms. (b) General catalogs covering the literature of a country or a particular field.

2. BIBLIOGRAPHIES.—Many lists of books and articles dealing with scientific and industrial problems are now available. Most of these are supplemented at irregular intervals. Similar lists, prepared on request, may be secured from certain organizations which maintain bibliographical services.

3. NOTES.—Notes may be in print or in manuscript. Those in print are to be found here and there in articles and chapters of books; those in manuscript, in the archives of government agencies and private corporations.

4. INDEXES.—Advances in library science have led to many annuals based on monthly or bi-monthly lists of articles dealing with specific subjects.

Value of Catalogs.—The extent to which library catalogs will prove useful depends upon a writer's familiarity with his subject. In practice, few scientists undertake research except in fields in which they have worked and in which they are specialists. Usually they are acquainted with the standard books. Except in cases such as the investigation into smoke abatement, where a comprehensive review of the literature available is required, scholars seldom find it necessary to consult treatises which are well known. Library catalogs are most valuable, therefore, because of their citations of rare monographs (published, it may be, privately) which have found their way into particular libraries and have not appeared in bibliographical manuals.

Of the compilations covering books in print in a particular country, one of the most important is *The United States Catalog* (New York, 1907–). Of those that cover a special field, the most pretentious is *The International Catalogue of Scien-*

tific Literature (London, 1902–), which includes, under author and subject indexes, all scientific publications within two years of issue. In general, it is of most service to those who are approaching a subject for the first time.

Value of Bibliographies.—In the same way, standard bibliographies are of great aid only to those who are not yet experts. For the beginner they are essential. Even to the more experienced investigator, they are often useful. Most libraries of any size now prepare special lists which are maintained for reference. Certain institutions, such as the public libraries of New York and Boston, occasionally issue these in pamphlet form. Although those in particular fields, such as the bibliographies of chemistry by Henry Carrington Bolton (Washington, D. C., 1899, 1901, 1904), are seldom abreast of recent developments, a specialized bibliography such as *Stainless Steel, A Digest with a Bibliography,* University of Michigan Engineering Research Bulletin 4 (1926), by Albert E. White and Claude L. Clark, which abstracts in chronological order all available papers on the subject from 1900 to 1926, is sometimes a useful tool. The only lists of great value to professionals, however, are those prepared in response to a definite request. Thus the Library of Congress will prepare, free of charge, bibliographies based on its resources. For a reasonable sum, the Library of the United Engineering Societies will perform a similar service; and, of course, the National Research Council, through its information bureau, will aid workers in the physical and biological sciences who may be in need of assistance. When its organization is perfected, the Council will doubtless be able to increase its usefulness. In the meantime, however, most bibliographies prepared by others are of more help to amateurs than to experts.

Value of Notes.—Similarly, because they are out of date before they appear, references in articles and chapters to parallel or supplementary interpretations are for beginners, not for specialists. On the other hand, those preserved in manuscript are often of the utmost importance. Many institutions maintain extensive files dealing with minor problems that have been

solved in their laboratories. Most companies keep in their safes corresponding data regarding discoveries made in their establishments. As a rule, these data are available to none except employees. In one of the great cement plants of the continent, only three chemists have access to the accumulated records of the organization. In a factory in Pennsylvania certain steps in a process developed by prolonged research have never been known by more than five members of the technical staff. Most firms possess similar trade "secrets" based on private investigations. Although the essential facts are seldom unfamiliar to the groups interested in them, a systematic collection is an undoubted asset.

Value of Indexes.—Even experts who are familiar with the files which are open to inspection must rely largely on indexes. As already suggested, those dealing with books may be discarded by the experienced investigator. Since knowledge expands rapidly, the periodicals which act as reporters of current achievements are most significant; and the guides to them are of first importance. Of those relating to engineering and industry, two are of general interest: *The Engineering Index* (New York, 1906–) and *The Industrial Arts Index* (New York, 1913–). The first, accumulated monthly, contains references to some 2,000 publications in 20 languages. The titles, formerly grouped under the chief divisions of engineering—civil, chemical, etc.—are now arranged alphabetically. The second, listing 330 periodicals, follows the same plan. It includes material relating to business from economic, transportation, and manufacturing periodicals, house organs, and trade journals. Similar indexes cover many of the other fields of modern life and thought. For instance, the *Education Index* (New York, 1929–) lists 150 periodicals in its field; the *Agricultural Index* (New York, 1916–), which notes articles from 227 periodicals in English, French, German, and Spanish, also includes experiment station and department of agriculture publications and proceedings of learned societies; and *Public Affairs Information Service* (New York, 1915–) combines an index of articles in economics, sociology, and political science with a digest of recent developments, indexing over 1,000

periodicals. Complete information regarding these and other indexes is to be found in Isadore Gilbert Mudge's *Guide to Reference Books* (Chicago, 1936). Valuable as such indexes undoubtedly are, it should not be forgotten that often the most important "leads" appear in those dealing with allied fields. The engineer and the architect, for instance, can often find something of significance in a compilation as remote from their subjects as *The Index Medicus* (Boston, New York, and Washington, D. C., 1879–), which particularizes the literature of medicine in every part of the world. It points to many avenues which are likely to attract those who are concerned with the health or comfort of the community.

Function of Abstracts.—Although some of the indexes mentioned above contain brief characterizations of the articles listed, their primary function is to direct attention to the articles themselves. Standing midway between index and article, and sharing the nature of each, is the abstract. It not only particularizes bibliographically the literature on a subject but also summarizes it succinctly. Of all abstracts, the most extensive and the most generally used is *Chemical Abstracts* (Easton, Pa., 1907–), issued semi-monthly, which covers approximately 2,800 periodicals in all the prominent modern languages and runs to thousands of pages. Other fields, also, are now adequately supplied with abstracts, of which the most important are: *Science Abstracts* (London, 1898–), divided into two sections: Section A, physics, abstracted from 273 periodicals in several languages, and Section B, electrical engineering, abstracted from 265 publications; *Biological Abstracts* (Philadelphia, 1926–), continuing *Abstracts of Biology* and *Botanical Abstracts,* which contains in its latest volume over 20,000 abstracts covering the world's literature in the fields of botany and bacteriology; and *Social Science Abstracts* (New York, 1929–), the youngest in the field, which is a selective index of signed abstracts covering important articles from over 4,000 periodicals in 24 languages.

Function of Proceedings and Transactions.—Another source that should not be overlooked is the proceedings and

transactions of the learned societies. In addition to numerous bulletins and monographs, most of them issue monthly reports, known as "proceedings," which are combined at the end of the year in the "transactions." The two terms are, however, used somewhat interchangeably. Some organizations prefer to call the papers read before societies "proceedings," as the *Proceedings* of the Institute of Radio Engineers, and others, "transactions," as the *Transactions* of the American Society of Civil Engineers. Those published in these volumes are often accompanied by discussions which throw additional light upon the subject in hand. Since they are generally referred to both in the standard indexes and in the abstract journals, they can be located without difficulty. Somewhat similar are the mimeographic services maintained by several bureaus of the federal government.

Exercise: A Bibliography.—Prepare a bibliography on one of the following subjects, on each of which much has been written. Employ one of the forms described in Chapter 20.

Aeroplane motors; atmospheric nitrogen; automobile transmission; ballistics; bagasse; beryllium; Byzantine architecture; cement; clay; concrete construction; dams and dam failures; desert flora; Diesel engines; electric welding; flotation process; fruit culture; fuel storage; gas turbines; heat transmission; heating systems; helium; Heroult electric furnace; hoisting machinery; hydro-electric development; hydrogen; hymenoptera; Imhoff tanks; industrial management; injurious insects; irrigation; landscape gardening; liquid fuels; mechanical flight; oil shales; paint; paper-making; parasites; paving materials; petroleum industry; pipe coverings; quantum theory; radio amplifiers; reforestation; sanitary chemistry; ship propulsion; textiles; timber and timbering; town and city planning; toxic drugs; vacuum tubes.

Use of Books.—After an investigator has completed his bibliography and has arranged it alphabetically on 3 x 5 cards, he is confronted with the task of mastering the books and articles listed in it. As before, the nature of this task is determined by his acquaintance with the subject. If it is slight, he must examine the monographs available. For such a study he should select a treatise that seems recent, comprehensive, and accurate. From this treatise as a starting point, he can delve into the subsidiary literature that is necessary to complete the background needed for research.

Use of Articles.—In most instances, however, the student will undertake the study with this foundation already laid. His chief problem, therefore, is to evaluate the articles dealing with contemporary developments. How can he determine their importance? Happily, there are four touchstones that will stand him in good stead. They are

1. Material
2. Moment
3. Manner
4. Man

1. MATERIAL.—If an investigator is an expert—and this is the only assumption that needs to be considered—the material will be more or less familiar to him. He will have some idea at least of its value. At any rate, he can establish it in proper perspective.

2. MOMENT.—For this purpose the date of publication is suggestive. To a scholar, to whom even the most minute note is a banner in the march of events, the date may show at once whether an article is decisive. On the other hand, if progress is rapid, neither material nor moment may be sufficient to fix its significance.

3. MANNER.—Even a specialist will be forced to look beyond the material and the moment to the manner of writing and to the writer, the man himself. Does the writer develop his subject coherently? Does he speak as one with knowledge? Is he generous in his comments on others? In short, is the impression which he creates that of a scientist who is logical, profound, and broad-minded? If it is, few will hesitate to accept his results. However, since scepticism is the highest attribute of the investigator, and since no tyranny is more dangerous than that of print, a student ought not to be content with a mere impression of authority. He ought to be assured of a writer's position.

4. MAN.—Certain challenges regarding age, education, accomplishment, and recognition are in order. These may be answered by reference to such biographical annuals and dic-

tionaries as *Who's Who* (London, 1849–), which deals chiefly with Great Britain; *Who's Who in America* (Chicago, 1899–), confined largely to men and women of the United States; *American Men of Science* (5th ed., New York, 1933), restricted to the United States and Canada; and *Who's Who in Engineering* (New York, 1937), devoted largely to American engineers. In them, age is always indicated. Many young men have achieved distinction in literature. A few have made their names immortal. Other things being equal, however, it is probable that those who have spent twenty or thirty years in specialization will make greater contributions to scholarship. When an article is the culmination of a series of monographs which have been tested by time, it is not unnatural to regard it as sounder than the more brilliant work of a newcomer. So with education. Many great inventors have had little formal preparation for their tasks. They have succeeded not on account of that fact but in spite of it—because, through genius, they have surmounted all obstacles. The institutions which a scholar has attended, the courses which he has pursued, the degrees which he has received, are therefore pertinent to an estimate. More pertinent still are his accomplishments. What experiments has he performed? What projects has he completed? What books and articles has he written? By whom have they been published? In what periodicals have they appeared? The answers to such questions are in themselves almost sufficient to determine finally the authoritativeness of a writer's pretensions. Nevertheless, his reputation must not be forgotten. Has he been welcomed by the great societies which represent the acme of professional success? Has he been recognized by the universities which maintain the traditions of scholarship? Has he been honored by his colleagues with positions of dignity and trust? If he has, those who follow in his steps need not hesitate to accept the credibility of his observations even if they do not care to accept the accuracy of his conclusions.

Exercise: The Evaluation of Articles.—Prepare an examination report on the value of six of the articles listed in your bibliography. Apply the four touchstones—material, moment, manner, and man—mentioned in the last section.

Four Phases in an Investigation.—As already indicated, what has been said in this chapter applies to the first phase of an investigation. There are four phases to be considered. They are:

1. The Preparation. A clearing of the ground.
2. The Procedure. A development of the campaign.
3. The Conclusion. A summary of the result.
4. The Report. A recapitulation of the research.

The investigator must discover the books and articles on his subject; he must decide which of these are significant, and he must master those that he selects. In this way he can learn what has been done and what remains to be done. With this knowledge, he can define his objective and can select the trails to be blazed. Although the procedure to be adopted in his advance is a matter of laboratory routine, dependent largely upon his knowledge and originality, it is well to ask how others have fared on similar expeditions. Their experiences will always be helpful. For this reason, the counsel and advice of teachers and colleagues should be sought without delay. With fuller information regarding realities and possibilities, it ought to be possible to gather materials, to construct apparatus, and to begin experimentation, tentatively at least, with confidence and dispatch. Once results have been obtained and interpreted to his satisfaction, an investigator can proceed with the draft of his report. The form to be followed is explained in the next chapters.

CHAPTER 18

EXPERIMENTAL RESEARCH REPORTS—LIMITATIONS

Arrangement.—The parts of a research report do not coincide exactly with the phases of the investigation. The main divisions, however, are the same; that is, there is a section dealing with preliminaries, a section dealing with experiments, and a section dealing with results. One exception is worthy of notice. The bibliography, which represents the first step in the process of research, appears as a supplement. Moreover, within any particular unit of the report the sequence may be entirely different from that followed in practice.

Introduction.—The introduction deserves to be considered in detail. The title page and the table of contents, which together form a kind of preface, are common to all types of report. Since the experimental report often appears as a monograph, intended primarily for the benefit of the author's colleagues, a formal letter of transmittal is seldom necessary. All three elements—the title page, the table of contents, and the foreword, whatever its nature—may therefore be dismissed without delay. The abstract alone demands special attention. Although it is not a fixture, it is peculiarly useful. So useful is it that at present most editors of research journals require one with every report submitted in the form of a special article.

Abstract.—In a single paragraph it is generally possible to indicate the purpose of the study and the nature of the conclusion. Two excellent examples have been quoted in Chapter 2. Each summary contains the gist of the report to which it is prefixed. Since miniatures of this kind are of aid not only to the reader who is concerned with his own immediate needs but also to the abstractor who may represent hundreds or thousands of investigators, every student should devote some time to the exercise suggested in Chapter 2.

Purpose.—The abstract cannot be written until the investigation and the text of the report have both been completed. In spite of its position, it is a kind of afterthought. The first phase of the text, on the other hand, is anticipatory. In it the object which the investigator has attempted to realize must be made clear to the reader. It may be indicated either formally or informally. Whether formal or informal, it may be relatively simple or complex.

A Formal Statement of Purpose.—The aim of the investigation may be stated in the baldest and most conventional manner.

From *Chemical Analysis of Logan Blackberry or Loganberry Juices,* United States Department of Agriculture Bulletin 773, by R. S. Hollingshead, Assistant Chemist, San Francisco Food and Drug Inspection Station.

(1)

The object of the investigation herein reported was to establish methods for the detection of dilution common in commercial products made from the Logan Blackberry and to set analytical standards for such products.

Since two of the qualities of the report are clearness and conciseness, such an indication of purpose has much to commend it.

Another Formal Statement of Purpose.—The tendency at present, however, is to expand the statement of object in such a way as to indicate the circumstances under which the purpose was afterwards realized. Thus, the extract below indicates the purposes of the report as well as those of the investigation. It is interesting to note that the investigator had in mind more than one object and that he uses an effective stylistic device to emphasize this fact.

From *The Performance of Propeller Fans,* Ohio State University Engineering Experiment Station Bulletin 77 (1933):

(2)

OBJECTS

The purposes of this bulletin are threefold: (1) to present an analysis of the power requirements for moving various quantities

of air against definite resistance, (2) to note and discuss observations made in the testing of propeller fans, and (3) to show the results of tests of propeller fans, mainly of the airplane propeller type.

The observations are based on tests of fifty or more fans which have been conducted in the mechanical engineering laboratory of The Ohio State University. Data are presented for 21 tests of 15 fans of various makes which represent a variety of designs and sizes ranging from approximately 12 to 28 inches in diameter.

In this instance, the first sentence is similar to that quoted in the preceding section. Although this sentence is clear and concise, the thought is not fully developed. Something is gained by relating the purpose of the investigation to the number of tests.

Taken together, these two passages are interesting because they indicate the methods which may be adopted in reporting a research. A writer may regard his work as a matter of history and therefore use the past tense. He may, however, invite his readers to accompany him on his adventures and so select the present. Though the first method is undoubtedly more in keeping with the character of the report, the second is more personal and more adapted to the monographic form in which results are often announced.

An Informal Statement of Purpose.—At present there is a tendency away from linguistic formulas in research reports. Hence it is becoming customary, in the preliminary statement, to define the purpose more informally than the previous illustrations indicate. In the following passage the phrases, "The purpose of this investigation . . ." or "The object of this study . . ." do not occur. From *The Resistance of Mine Timbers to the Flow of Air as Determined by Models*, University of Illinois Experiment Station Bulletin 279 (1935), by Cloyde M. Smith:

(3)

I. INTRODUCTION

1. NATURE OF INVESTIGATION.—In underground mining it is commonly necessary to support some of the passageways artificially. This is usually done by installing timber supports at inter-

vals along the passageway, many different types of supports having been used to meet local needs. In nearly all cases timber partly obstructs the passage, thereby offering a large resistance to the flow of the ventilating current of air along the passageway.

Where a high rate of air flow must be maintained to ventilate the workings properly, the resistance of the mine timbers to the flow of air adds considerably to the cost of ventilation, and this investigation was undertaken to determine the resistance of different forms of timbering and to compare their effectiveness and economy as underground supports.

Small-scale models of timbers of several kinds were spaced regularly in a model of a mine entry, and the resistance of these model timbers to the flow of air was measured over a suitable range in the rate of flow. This led to a comparative evaluation of the different kinds of timbering, and yielded indications as to the optimum choice of timbering, to suit a given condition.

Contrasted with those in the last two sections, the references are less mechanical.

Another Informal Statement of Purpose.—In order that it may be fully understood, the aim is sometimes developed through a study of previous conditions. For example:

From *The Flow of Water Through Orifices*, Ohio State University Engineering Experiment Station Bulletin 89 (1935), by S. R. Beitler, in coöperation with the American Gas Association, the American Society of Mechanical Engineers, and the Bailey Meter Company:

(4)

Two of the developments of our modern civilization which have occurred very rapidly in the last twenty years are the transportation of fluids in pipes and the development of electric power from steam and water power.

One of the results of the rise of these industries is a demand for accurate meters to measure the flow in pipes at a minimum of cost. The displacement meter familiar to every purchaser of gas and water is used for the measurement of small flows, but it cannot be built for large size or for high pressures at any reasonable cost.

For this reason some kind of inferential head type of meter has

been substituted. The first inferential head meter in general use, the venturi meter, is still used a great deal in the measurement of water. However, the fact that the initial cost is relatively high and that it is difficult to change the capacity of the meter has militated against its general adoption by other industries.

In the early day of the natural gas industry and in the early power plants the Pitot tube was used a great deal, but this was found to be relatively inaccurate for low flows, and difficult to use. The thin plate orifice was then tried and, having been found to fulfill nearly all the requirements for most large measurements, is in almost universal use for the metering of natural gas, steam, oil, and air, and in a great many cases water and other fluids.

The most common type of orifice meter consists of an orifice plate and pressure taps, known as the primary element, and a mechanism, known as a secondary element, for recording the pressure drop across the orifice and the static pressure and temperature at the orifice if a gas or vapor is being measured. The secondary element, if properly constructed and operated, can be made to give very accurate readings of differential pressure, etc., and the secondary elements built by any reputable manufacturer will probably give accurate indications of the flow through an orifice.

A study of available data on characteristics of the orifice as a primary element, available in 1929, showed that the knowledge of flow constants or coefficients of orifices was rather sketchy. This was especially true of the constants for the measurement of steam. The Bailey Meter Company of Cleveland, who are manufacturers of orifice meters, feeling the need of additional knowledge of these coefficients, entered into a coöperative agreement with the Experiment Station to make some tests using steam and water as the calibrating fluids. This work was started on orifices in a 6-in. pipe, but because the steam capacity of the laboratory was limited the line size was changed to three inches, and a complete series of orifices calibrated, using both water and steam. This calibration was done by Mr. T. C. Barnes and Mr. R. L. Galley of the Bailey Meter Company organization, with the aid of several assistants and under the direct supervision of Professor Paul Bucher and the writer. Partial reports covering this work were given in two papers published by the A.S.M.E., one presented in 1929 on "The Calibration of Orifices in a Six-Inch Line" by Professor Bucher and the writer (A.S.M.E. Hy. 52-7A); and the other, presented in 1931, on "A Study of Primary Metering Elements in Three-Inch Pipe" by Professor Bucher, Mr. Barnes, and the writer

(RP 54-). These reports covered work done on special orifices, nozzles, and venturi meters in addition to concentric orifices. . . .

In 1931 a committee of the American Gas Association which had been formed in 1924 to study the behavior of orifices measuring natural gas joined with the Fluid Meters Committee of the American Society of Mechanical Engineers to form a joint committee on orifice meters. This Committee consisted of the following members; . . .

This Committee studied the data on orifices available at this time and found that, although the amount of data available was large, the arrangement was rather spotty and the range of orifices used commercially was not fully covered. At a meeting of the Committee held in December, 1931, it was decided to have some additional work done on the calibration of orifices in order to cover the complete range of usage.

A coöperative agreement covering this work was signed by the Committee and the Experiment Station early in 1932, and work was started in March of that year. . . .

A very good discussion of the installation of meters and the use of flange and pipe taps will be found in Report No. 2 of the Gas Measurement Committee of the Natural Gas Department of the American Gas Association, which is at present available, while a more complete discussion can be found in Part 1 of the Report of the Special Research Committee on Fluid Meters of the American Society of Mechanical Engineers. This is at present being revised and will be available in the near future.

In general these tests were conducted on commercial orifices installed in sections of commercial pipe, and the results therefore should apply to any orifice installation, providing care is taken to properly construct the orifice and to choose clean and smooth pipe.

It seems clear after five years' experimentation in the calibration of fluid meters of various sorts that the orifice meter is the most easily reproduced and cheapest type of differential head meter, and if properly used, with the correct coefficients, is as accurate as any other type of meter. For these reasons it is, therefore, the best type of primary element to use.

However, it must be remembered that for extremely small or large flows other meters are probably more accurate than the orifice meter. Anyone wishing to use orifice meters should secure the reports of the American Gas Association and American Society of Mechanical Engineers and follow the recommendations given there.

The purpose of this work was to determine the variation of discharge coefficient (for various types of pressure taps) of sharp-edged concentric orifices with pipe size, edge roundness, diameter ratio, edge thickness, and differential head.

Here the object of the research would not be clear without the historical data presented by Professor Beitler. It is interesting to note, also, that the importance and value of the study are both stressed in the statement.

Definition of Terms.— A mere statement of the purpose which an investigator has in view is seldom sufficient to explain the nature of the undertaking with which he is concerned. The meaning which he attaches to particular words and phrases is often significant. It must be fixed at the beginning of the text. The process of definition—for such it is—depends upon the character of the terms in question; that is, whether they refer to objects or to ideas. If they are concrete, the definition will probably be formal; if they are abstract, it will probably be informal.

Formal Definition.—Formal definition is the process by which an object is assigned to its class and then described by reference to its particularizing characteristics. In most cases the class to which it belongs is so obvious that the definition is restricted to the *differentiæ,* the features which separate it from other members of the *genus.* In the following extract from *Smoke Abatement,* the writer assumes familiarity with the essentials of any contact systems. The definition is therefore a kind of inventory of the special qualities that distinguish the overhead type:

(5)

213.022. DEFINITION.—The overhead type of contact system for the delivery of electric current to locomotives and cars has been made the basis of estimates of the cost of equipping the railroad lines of the Chicago terminals for electric operation. This type of contact system consists of one or more conductor wires of suitable size and material, suspended in desired position above the track from a catenary messenger wire, and of steel structures, or poles of wood or steel, set at intervals along the line to support and maintain the position of the wires.

Somewhat similar is the definition of a conductor in the *Standards of the American Institute of Electrical Engineers* (New York, 1922), Section 9001:

(6)

CONDUCTOR.—A wire or combination of wires, not insulated from one another, suitable for carrying a single electric current. The term "conductor" is not to include a combination of conductors insulated from one another which would be suitable for carrying several different electric currents.

Rolled conductors (such as busbars) are, of course, conductors, but are not considered under the terminology here given.

Almost the same method is followed. The class is "a wire or combination of wires"; the particularizing characteristics are non-insulation and suitability "for carrying a single electric current."

Often, as suggested by the passage above, the definition is exactly consonant with the meaning of the term used to indicate the process. It is a kind of demarcation in which diagrams may be employed to advantage. An excellent instance is to be found in the *Report of the Committee on Standardization of Special Threads for Fixtures and Fittings on Straight Pipe Threads,* American Society of Mechanical Engineers, 1915.

(7)

DEFINITIONS OF TERMS USED

The term "outside diameter" used in this report refers in the case of male threads to the top of the threads or largest diameter, and in the case of female threads to the bottom of the threads or largest diameter. The term "root diameter" similarly refers to the smallest diameter. The "pitch diameter" is of course determined by subtracting from the outside diameter of a theoretical full V-thread the single depth of the thread. Fig. 1 illustrates these various diameters. [See page 440.]

A definition will sometimes gain in clearness and effectiveness if the *differentiæ* are listed in outline form. In the following illustration from *Department Leasing in Department Stores,* Harvard University Graduate School of Business Administration, Business Research Studies 4 (1933), by Stanley F. Teele,

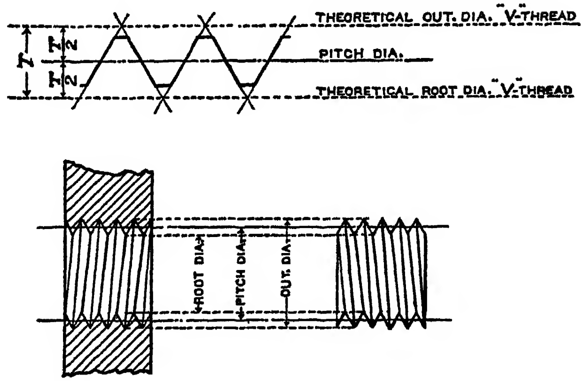

Figure 1. Outside, Pitch, and Root Diameters

the arrangement and form give importance to the "four major characteristics:"

(8)

The method of selling at retail known as department leasing, simply defined, is the operation of a part of a store by an individual or firm other than the one operating the store itself. The leased department has four major characteristics which serve to differentiate it from several other types of arrangements, notably certain forms of exclusive agencies and consignment agreements, which are similar to leasing in some respects:

(1) The lessee is an independent business man or firm.
(2) The lessee has control of all merchandising activities.
(3) The lessee deals with the public under the firm name of the lessor.
(4) The lessee has a personal representative in the store.[1]

Exercise: A Formal Definition.—Define formally one of the following terms:

Annealing; boilers; cathedral; coal; copper; cornice; crane; diamond; elevator; ferro-manganese; fungus; frieze; gasoline; girder; pylon; capstan; sequoia; soda; slag; wheat.

Informal Definition.—Where the terms are concrete, and where diagrams can therefore be employed, the task of defini-

[1] Reprinted by permission of the Harvard Bureau of Business Research.

tion is relatively simple. Where the terms are abstract, however, the process requires study, patience, and skill. Under these circumstances it is usual to begin with a definition which is popular, or at least current, and to amend it by the methods indicated in succeeding paragraphs. In the extract from *Smoke Abatement* below, the writer analyzes the conceptions of smoke which have prevailed since the seventeenth century, accepting in the end as most exact and inclusive a description by a German investigator, Wolpert:

(9)

101.02. DEFINITIONS OF SMOKE.—Two conceptions of smoke have prevailed: one, which regards it, to use the words of Dr. Johnson's *Dictionary*, as "the visible effluvium or sooty exhalation of anything burning"; another, which takes account of the invisible as well as of the visible constituents. The former is the older conception and represents even today the view popularly entertained. No matter how great a volume of invisible gaseous products of combustion may be sent forth by a chimney, the chimney, in common parlance, is said not to smoke so long as it emits no visible exhalation. Modern dictionaries and cyclopedias, taking account of this, usually add to the old definition some such statements as the following: "Hence, sometimes, technically, any such incompletely burned volatilized product, whether visible or not";* "in its more extended sense, the word 'smoke' is applied to all the volatile products of combustion which consist of gaseous exhalations charged with minute portions of carbonaceous matter or soot."† A German investigator of air pollution, Wolpert, gives perhaps the most exact and inclusive definition of smoke by describing it as "the products of combustion diffused in air."

* *The New International Dictionary.*
† *The Imperial Dictionary.*

Still unsatisfied, the writer has recourse to the regulations which reflect the meaning attached to the term in different municipalities:

(10)

101.03. SMOKE AS DEFINED BY THE ORDINANCES.—In general, the prohibition of smoke ordinances relates to smoke in its visible aspect. The New York City, Toronto, Minneapolis, Denver, Des

Moines, and Milwaukee ordinances prohibit "dense smoke." In Baltimore, it is "black or dark gray smoke"; in Knoxville, "dense black or dense gray smoke"; in Springfield, Mass., "dark smoke or dense gray smoke"; in St. Louis, "dense black or thick gray smoke"; in Winnipeg, Toledo, Indianapolis, Richmond, Ind., and Reading, Pa., "dense black or gray smoke." In the cities of Great Britain, it is "black smoke"; in Paris, France, "black, thick, and continuous smoke"; in the cities of Germany, "smoke containing soot in visible quantities." In a few ordinances—for example, those of Buffalo, Cleveland, London, and Munich—"noxious gases or vapors or offensive odors" are prohibited; and recent British legislation has specifically included "mineral grit." The Philadelphia ordinance attempts greater precision by specifying "smoke intercepting more than 60 per cent of light, and fumes of sulphurous or noxious odor." In Yonkers, N. Y., the ordinance prohibits "smoke, cinders, dust, gas detrimental or annoying to any persons not engaged on the premises."

Obviously, the terms by which objectionable smoke is defined in the smoke abatement ordinances are not precise. In many cases they have been found too elastic to enable proper enforcement of the ordinance. A comprehensive definition of smoke must take account of the process by which smoke is produced, the nature and composition of its constituents, the manner in which these may be diffused in the air, and the degree to which they may, separately or collectively, be regarded as injurious.

As a result of this survey, he comes to the conclusion of the last sentence: "A comprehensive definition of smoke must take account of the process by which smoke is produced, the nature and composition of its constituents, the manner in which they may be diffused in the air, and the degree to which they may, separately or collectively, be regarded as injurious." Following these avenues, he reaches the limits fixed by the next quotation:

(11)

The significance of these facts is emphasized by the results of the investigations herein described; and, in recognition of them, the term "smoke," as hereinafter used, refers to the gaseous and solid products of combustion, visible and invisible, including, in the case of certain industrial fires, mineral and other substances carried into the atmosphere with the products of combustion.

To begin with a preliminary or tentative definition and, by a process of inclusion and exclusion, to establish one that is accurate and comprehensive—such, in general, is the procedure where the terms are not susceptible of formal treatment. Where they are abstract, this method is nearly always advisable. In the quotation from *Profit Sharing,* the common limitation is gradually enlarged until the content is fixed by a series of comparisons:

(12)

Definition

In a study of the subject of profit sharing, it is necessary to indicate clearly what is meant by the term profits. According to the International Coöperative Congress held in Delft, Holland, in 1897, profits should be considered as

> the actual net balance of gain realized by the financial operations of the undertaking in relation to which the scheme exists.

The important point here is that profits are the net profits of the accountant, i. e., the net sum left over at the end of the fiscal year, after all funds set aside for purposes that many be considered as debits have been deducted. This does not include deductions for new ventures or for expansions. Funds that have been created, however, for depreciation, insurance, and other benefits, or for similar purposes, must be subtracted before net profits are determined. Allocations under true profit sharing and wage bonus plans are made after net profits have been calculated, while in savings sharing and stock subscription plans they are generally made before that bookkeeping stage is arrived at; but in all these plans, whether or not the share allocated to workers is taken out before or after net profits are reached, so far as the meaning of net profits is concerned the present study indicates that with few exceptions the definition of the Delft Congress is generally followed in practice.

The distinguishing feature of true profit sharing is that the share of net profits to be allocated varies directly, and rises or falls proportionately, with an increase or decrease in the profits realized. The size of the workers' share, as has been indicated, is presumed to depend on how profitable they themselves help to make the enterprise. The total amount of net profits cannot of course be predetermined. It will be large in good years and small in dull

ones. The proportion to be distributed to the workers, however, can be decided upon beforehand. This predetermination of the percentage has come to be an established practice under true profit sharing plans.

The outstanding characteristics, therefore, of true profit sharing are: first, that the employer engages to distribute to his employees a share of net profits; and, second, that the actual percentage of this participation is fixed in advance.* The percentage thus prearranged may or may not be announced to the workers, although it is obviously a matter of wise policy that the workers be informed not only that a percentage has been fixed beforehand, but also as to what the actual percentage or determining relation is; and this, with but an occasional exception, has been found to be the general policy.

Wage bonuses differ from profit sharing in that they are distributions, usually made annually, which are determined arbitrarily and bear no predetermined relation either to dividends or to profits. The amounts and regularity of payments are entirely discretionary with the employer. Bonuses are paid in amounts usually based solely upon a percentage of the workmen's annual earnings. Sometimes they are allotted even though no profits have accrued.

Savings sharing plans distribute a portion of the savings effected in cost of production by increased efficiency and coöperation of the working force. The amount to be distributed bears no fixed relation to net profits, much less a relation determinable in advance, for the reason that, while there may be savings in production, the sales or other departments may show losses and no net profits at all may be realized. Net profits are determined not alone by the cost of production, but by other factors as well. In other words, savings sharing plans are to be distinguished from true profit sharing in that they depend upon savings in production and not upon net profits.

As has been said, stock subscription plans are essentially a matter of the employee's investing his money in shares of the company's stock. These shares are obtained in much the same way by the worker as by any other investor. The returns which he receives, therefore, in addition to his wages, come to him as an investor and not as a wage-earner. The only extra remuneration obtained is in the form of premiums and easy terms of payment.

Those plans for sharing profits which are limited to the principal or managerial employees of an establishment, and which ex-

* Sometimes the allocated share is related directly to dividends.

clude participation by the rank and file, are known as limited profit sharing plans. These are based on the same principles as true profit sharing. The only distinction lies in their limited application.

From the foregoing analysis, it follows that true profit sharing is a form of remuneration of employees which is voluntary on the employer's part and is supplemental to the regular wage, and which distributes to a representative portion of the working force, for the purpose of securing its coöperation and loyalty, a percentage, fixed in advance, of the net profits of the enterprise.

In this passage the significance of profit sharing is established by contrasting it with wage bonuses, savings sharing plans, and stock subscription plans. Many terms used in discussions of industrial and social relations may be so defined.

Occasionally definitions of such terms may be developed even more informally. An excellent example of the "human interest" type, realized by means of narrative, is to be found in *Truck Selling,* Harvard University Graduate School of Business Administration Business Research Studies, 7 (1934), by Lars J. Sandberg, Instructor in Marketing.

(13)

A man in a white uniform drives up to a grocery store, stops his truck abruptly, jumps out, and runs inside the store. He secures an order for goods, and immediately he brings those goods in from his truck. He collects payment for the goods, runs out to his truck, and drives on to another store. The complete transaction, including sale, delivery, and collection, has taken a little over a minute. This is simultaneous selling and delivery.

Simultaneous selling and delivery, strictly speaking, is the performance of the selling and delivery functions at the same time by the same person. With other methods of selling, a salesman secures orders for goods at one time, and a delivery man effects delivery of the goods at a later time. Simultaneous selling and delivery combines the salesman and the delivery man into a driver-salesman, and eliminates the time interval between sale and delivery. These time and agent factors are the only essential characteristics of simultaneous selling and delivery. The white uniform, the collection of cash, and even the truck are common but nonessential features of this method of selling.[2]

[2] Reprinted by permission of the Harvard Bureau of Business Research.

Although "simultaneous selling and delivery" is an accurate definition of the subject, the term is not convenient for purposes of continuous discussion. Consequently, other more convenient terms are used in this study, terms which have no special importance in themselves. Simultaneous selling and delivery is referred to as "truck selling." The driver-salesmen are called "truck salesmen." Wholesalers using this method of selling are called "truck wholesalers." Manufacturers using this method of selling to retail stores are termed "manufacturers using truck selling."

Exercise: An Informal Definition.—Define informally one of the following terms:

Agronomy; assaying; bolshevism; catalysis; center; contract; current; deforestation; displacement; histology; impregnation; mycology; partnership; projection; silviculture; socialism; stratigraphy; taxonomy; trust; weathering.

Emphasis on Importance.—Although there are always inventors and scientists, there are not always patrons and benefactors. Nor are there always readers. Unless an investigator has been requested to solve a specific problem, and has therefore been exempted from the necessity of securing an audience, and ultimately a coterie of supporters, he ought to emphasize, where possible, the importance of his work. Even if a subject is not directly utilitarian in character, a reference to its significance is always proper.

In *A Study of the Reactions of Various Inorganic and Organic Salts in Preventing Scale in Steam Boilers,* University of Illinois Engineering Experiment Station Bulletin 283 (1936), Professor Frederick G. Straub appeals in his opening sentence to engineers in power plants:

(14)

1. Purpose of Investigation.—Engineers in power plants are continuously facing the problem of scale prevention in steam boilers. In attempting to prevent the formation of scale it is essential that they have available data from which to formulate or select the particular treatment required. The purpose of this investigation has been to study methods of chemical treatment which might be used for the prevention of the various types of scale which form in steam boilers.

Since the chemical treatment of boiler water may be readily classified under two distinct headings, inorganic and organic, it was thought advisable to divide this study into two parts. Therefore, the results of this work will be discussed under the two main headings, Inorganic and Organic.

More often, however, as in the following extract from *Smoke Abatement,* it is sufficient to show that interest in the subject has been persistent, and that the need for an investigation has been generally recognized.

(15)

102.01. Public Interest in Smoke Abatement.—Smoke abatement in Chicago has been a subject of public interest for more than 40 years. This interest has found expression in newspaper discussions, in public addresses, in the action of unofficial or voluntary societies and associations, and in the enactment of various ordinances by the City Council. In 1874, and for a number of years thereafter, the work of smoke abatement was stimulated by the "Citizens Association," a voluntary organization having for its object the promotion of public welfare. This association appears to have concerned itself chiefly with the legal and legislative aspects of the problem. After the first smoke abatement ordinance was enacted, it assisted in the prosecution of violators, and insisted that those in charge of public buildings, office buildings, schools, pumping stations, and other public institutions should not offend the law. It cordially supported recommendations made by the Mayor in 1905 regarding modifications in the methods of enforcement of the smoke abatement ordinance, and it conducted two or three investigations which exerted an influence upon the subsequent enactment and enforcement of legislation.

In the early days, there was much discussion concerning the practicability of abating smoke and the right of the city to require its abatement. Differences of opinion arose as to the procedure best calculated to bring about the desired results.

In 1891, "The Society for the Prevention of Smoke" was organized through the patronage of a number of public spirited citizens. This society, with several other voluntary organizations formed at this time, had for its main purpose the physical betterment of the city preparatory to the World's Fair in 1893. The officers and directors were business men of Chicago, and the staff included engineers and experts. The methods adopted were educa-

tive and coöperative. The work was vigorously pushed, and the large expense involved was borne by private subscription. The daily papers gave it their constant and consistent support. Inspections and tests were made of plants which violated the smoke ordinance, and reports containing suggestions for changes of equipment, fuel, or methods of operation were submitted to the owners. The effort was to show that no pecuniary loss need be involved in the abatement of smoke nor in the use of smoke-abating appliances. Particular attention was paid to smoke from steam locomotives, and the use of several smoke-abating devices was inaugurated. The activities of the society ceased in 1893, its work having been, in a measure, accomplished.

More recently, numerous organizations have interested themselves in the general problem of smoke abatement, but have accomplished little except in so far as they have stimulated interest in the subject. Few new facts have been developed, but, in response perhaps to these manifestations of public interest, a gradually developing train of municipal legislation has appeared, a brief review of which is important in this connection.

Historical Review.—The last sentence leads to a phase of the report which coincides with the first step in the investigation itself—an epitome of what has been accomplished in the field of research. This epitome should help the reader, who may not be familiar with developments, to appreciate the significance of the contribution in hand. Its aim is to place him in the position which the author has reached through the long and inevitably tedious process described in Chapter 17. To marshal in a few paragraphs the facts necessary to establish this vantage ground is not a simple task. A writer's reputation will be affected materially by the measure of his success. Omission of an important discovery or inclusion of an unimportant one may be sufficient to discredit his knowledge and ability. No part of the report requires a keener sense of proportion. No part demands more careful workmanship.

It is difficult to indicate the character of this résumé. Two points, however, ought to be emphasized. As it contains a survey of progress to the date of investigation, one purpose is to fix events in chronological order. Another is to establish a "take-off." The summary consists, therefore, of a statement of status based on general movements or particular ac-

complishments. Attention may be directed toward (1) the emergence of tendencies or (2) the work of individuals.

From *An Investigation of Reinforced Concrete Columns,* University of Illinois Engineering Experiment Station Bulletin 267 (1934), by Frank E. Richart and Rex L. Brown:

(16)

1. Origin and Object of Investigation.—The strength of reinforced concrete columns, their behavior under various conditions of loading, and proper rules for their design have been the subject of intense interest and frequent controversy among structural engineers during the past thirty years. Much of the difference of opinion centers about the action of helical or so-called spiral reinforcement, introduced about 1899 by A. Considere. Considere made tests and displayed remarkable insight in explaining the complex action of such reinforcement; he was followed by a long line of experimenters, including Morsch, Talbot, Bach, Graf, Withey, Emperger, von Thullie and many others, who in the period 1900 to 1916 studied various phases of concrete column action. Of more than 1600 published concrete column tests on record in 1930 (about two-thirds made in Europe and one-third in the United States), 97 per cent had been made before 1916. While these tests furnished the basis for present design practice, they cannot be unified because of wide differences in testing technique, incomplete records, variations in quality of materials, and a great lack of modern strain measurements. In 1921, F. R. McMillan demonstrated the important effect of shrinkage and time yield of concrete upon the deformations and the resulting stresses in the reinforcement. This development, together with the growing use of materials outside the range of test information, led to a plan in 1929 for a comprehensive column investigation under the direction of Committee 105 of the American Concrete Institute. Coöperative agreements were made between the Institute and both the University of Illinois and Lehigh University to carry out the test program, much of which was duplicated at the two laboratories.

From *Measurements of Vapor Pressure of Certain Potassium Compounds,* Columbia University Engineering and Scientific Papers 5[8] (1921), by Daniel J. Jackson and Jerome J. Morgan.

[8] Reprinted from the *Journal of Industrial and Engineering Chemistry,* XIII, 110-118 (1921).

(17)

Previous Work

In 1866, Bunsen* determined the relative volatility of certain salts by heating a centigram bead of the salt on a platinum wire in the hottest part of a Bunsen flame and measuring the time required for the salt to volatilize. In 1897, Norton and Roth† repeated and extended the work of Bunsen. The volatility of sodium chloride thus measured in each case was taken as unity. The results of these investigators, as far as they relate to potassium compounds, are given in Table 1.

Bergstrom,‡ in 1915, found the boiling points of the potassium halides to be as follows: potassium chloride 1500°, potassuim bromide 1435°, and potassium iodide 1420°. Niggli** found that a mixture of potassium carbonate and silica heated for 60 hrs. at 900° to 1100° lost 15 mg. of K_2O. In addition many of the recent articles dealing with processes for recovering potash from silicates contain statements as to the relative volatility of certain potassium compounds, but, with the exception of the work of Anderson and Nestell***, it is believed that there has been no previous quantitative study on the volatilization of potassium compounds.

TABLE I

VOLATILITY OF POTASSIUM COMPOUNDS, TAKING THE VOLATILITY OF SODIUM CHLORIDE AS UNITY

Compound	Results of Bunsen	Results of Norton and Roth
Iodide	2.828	2.362
Bromide	2.055	1.860
Chloride	1.288	1.083
Fluoride	.....	0.329
Carbonate	0.310	0.277
Sulfate	0.127	0.149

* *Ann.*, 138, 263; *Jahresb.*, 1866, 770.
† *J. Am. Chem. Soc.*, 19 (1897), 155.
‡ *Med. Finska Kemistsamfundet* (Swedish) 24 (1915), 2; through *Chem. Abs.*, 9 (1915), 2361.
** *Z. anorg. Chem.*, 85, 234; *J. Am. Chem. Soc.*, 35 (1913), 1693.
****J. Ind. Eng. Chem.*, 9 (1917), 253

These two extracts illustrate the points of view from which an historical summary may be developed. In the first, Mr. Rickart and Mr. Brown cite the developments motivating previous investigations. In the second, Messrs. Jackson and Morgan merely mention Bunsen, Norton, Roth, and others who have made definite contributions to the measurement of vapor pressure. Though most writers adopt one method or the other without giving much thought to the matter, each is undoubtedly based upon a distinct theory of progress in any art or science. Some historians regard tendencies as supreme and men as little more than creatures of circumstance. Others think of achievements in terms of "heroes" who dominate their age. To John Fiske, the historian, for instance, the New England town meeting was the legitimate descendant of the parish vestry of Old England. To Carlyle, on the other hand, the Puritan Commonwealth was Cromwell, the Lord Protector. Though both of these allusions are remote from the material of reports, the methods of approach which they illustrate can always be used to advantage in the interpretation of the past.

Exercise: An Historical Review.—Prepare an historical review, based on either tendencies or personalities, on one of the subjects listed on page 428. If the available material consists of a few articles only, you may find it well to reproduce them in the form of abstracts. If you do not succeed in finding any articles, state this fact, enumerating also the sources which you have explored. A list of this kind, which is never out of place, will show that you have overlooked no possibilities. This exercise will not only help you to master a specific field but it will also help you to establish a philosophic attitude toward data of any kind.

Scope.—After the status of the subject has been clarified, a reference to the limits of the research is imperative. These will be determined by the character of the theme. In cases like the following, the restriction is one of area. Under such circumstances, cartograms are useful in fixing the boundaries.

From *Smoke Abatement:*

(18)

103.01. The Area of Investigation.—In entering upon a study of Chicago's atmosphere and of the sources of its pollution, it was early determined to give attention not merely to the area

within the corporate limits of the city but also to a limited area of outlying territory. The activities of the city and of its suburbs intermingle, and the interests of residents of city and suburb are in many respects common. Moreover, smoke in the atmosphere is extremely portable. When carried over the city from outside sources, smoke is as effective in polluting the atmosphere as when

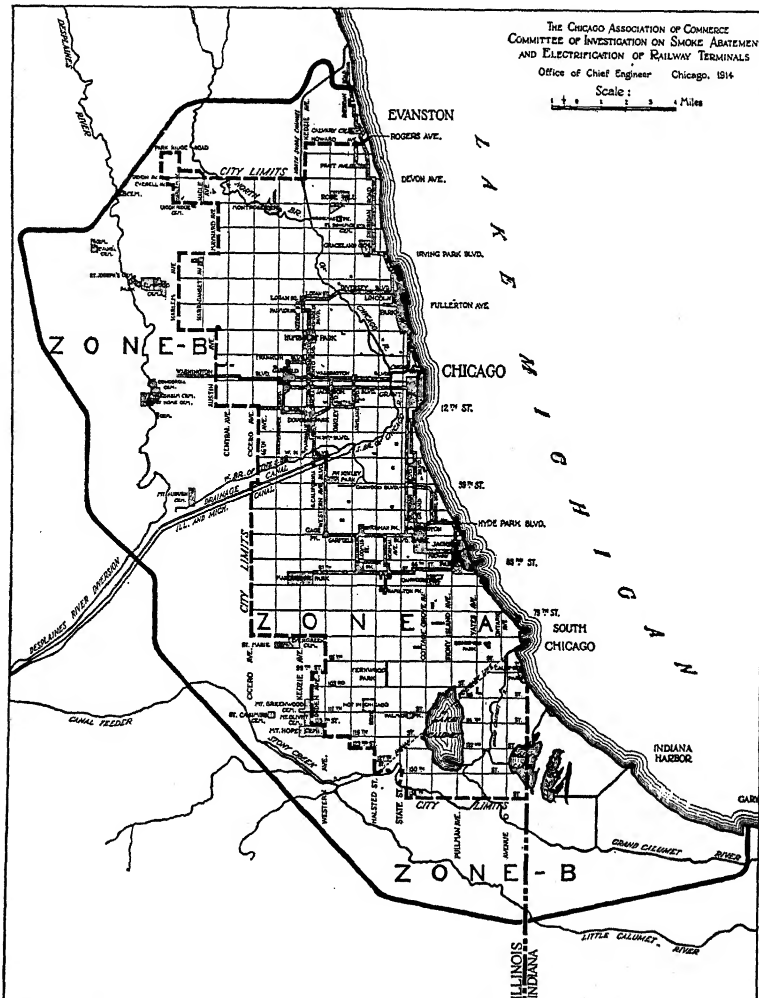

Figure 8. The Committee's Area of Investigation

arising from sources within the city itself. After careful consideration had been given the various manufacturing and transportation activities to be included, the Area of Investigation was defined as that which lies between Lake Michigan and the boundary indicated by a black line drawn on the official map of the Committee. The area is shown by Fig. 8 in its relation to certain well

Figure 9. The Committee's Area of Investigation, Emphasizing Location of Railroads

known geographical features, and by Fig. 9 in its relation to the location of railroads.

Further on, in connection with another phase of the subject, limitation by area merges into one by mileage governed by certain specific conditions which are explained later.

(19)

209.01. The Need of Defined Limits.—Any estimate of the cost of equipping the railroad terminals of Chicago for electric operation, and of the expense of operation subsequent thereto, depends upon the extent of the plan of electrification. For reasons which will hereafter become apparent, the area defined as Zones A and B, which have served in the Committee's study of smoke and atmospheric pollution (Chapters 104 to 113) cannot be employed to advantage in defining the limits of electrification, and no use is made of them in this connection. Instead of attempting to establish a zone of electrification, the extent of trackage to be dealt with has been fixed for each railroad. Points have been selected for the outer termini of electric operation with reference to certain general considerations inherent in the problem. The more important of these considerations are set forth in the sections which follow.

In the following examples the character of the limitation is different. In the first instance, it relates to the number of companies in which the investigation has been pursued; in the second, to the kind of wood and the form of test.

From *Employee Thrift and Investment Plans*, New York, (1929), by the National Industrial Conference Board:

(20)

Scope of Survey

The purpose of this study has been to analyze a considerable number of plans in active operation for stimulating thrift among employees in order to ascertain the provisions of the various plans, the mechanics of their operations and the general results which appear to have been accomplished through their use. The data contained herein are made available through the courtesy of 319 companies, which together employ approximately one and a third million wage earners. Table 1 shows a distribution of the

TABLE 1. CLASSIFICATION OF THRIFT PLANS BY TYPE
(Source: National Industrial Conference Board)

TYPE OF PLAN		NUMBER OF PLANS
SAVINGS IN BANKING INSTITUTIONS:		
Branch banks (operated by bank)	3	
Branch banks (operated by company)	4	
Savings collected by bank representatives	6	
Savings collected by company representatives	2	
Payroll deductions	115	
Employees' thrift club	5	
Savings and insurance	4	
Savings stamps	5	
Christmas and vacation clubs	40	
Bonus for savings deposited in bank by employee	3	
Total		187
EMPLOYER AND EMPLOYEE SAVINGS AND INVESTMENT FUNDS:		
Company fund	22	
Thrift certificates	13	
Investment fund	17	
Investment fund, supplemented by employer contribution	15	
Total		67
SAVINGS COMBINED WITH LOANS:		
Credit unions	38	
Other small loan and savings plans	9	
Building and loan associations	17	
Other large loan and savings plans	6	
Total		70
Grand total		324*

* The discrepancy between number of plans and number of companies is due to the fact that some companies have more than one thrift plan.

plans studied among the three main basic classifications, and also among the minor variations of the three groups. Table 2 [omitted] indicates the distribution of the various plans on the basis of size of establishment.

So many industrial relations activities are intended, directly or indirectly, to stimulate thrift on the part of employees, that it has been necessary to limit somewhat arbitrarily the types of plans to be covered in this study. For example, employee stock purchase plans have not been treated because such investments may not readily be convertible into cash if desired, and also because this subject has already been given comprehensive treatment in another volume. These stock purchase plans, however, represent an important branch of thrift incentives. In 1927 the National Industrial Conference Board found 389 companies which had sold, or were selling, securities to their employees. In the 315 companies which provided detailed information, stock with a value exceeding a billion dollars was owned or being paid for by over 800,000 employees. These plans for assisting employees to own sound, dividend-paying securities by offering them at lower than the market price or by spreading the payment for them over one or more years, or by both devices, have become an important feature of thrift programs. Likewise, contributory forms of life and sickness or accident insurance have an important bearing on the employee's financial status but are not thought of as savings or investment plans. This study has been confined to plans which have been considered as offering the means of accumulating savings which may be withdrawn at will.

From *Tests of the Absorption and Penetration of Coal Tar and Creosote in Longleaf Pine,* United States Department of Agriculture Bulletin 607, by Clyde H. Teesdale, Section of Wood Preservation, and J. D. MacLean, Forest Products Laboratory.

(21)

The most important variables in the treatment of wood affecting absorption and penetration are: (1) The species, character, and condition of the wood; (2) the properties of the oil; and (3) the methods of treatment. To eliminate the variability due to species, and to reduce that due to the character and condition of the wood, the experiments were confined to wood of one species (longleaf pine), and so far as possible specimens of uniform quality were

selected. This made more readily determinable the relative importance of variations in the oil and in methods of treatment.

The relative absorptions and penetrations were determined by two forms of tests:

1. Penetrance tests, in which the preservative was applied to a small area in the specimen and measurements made of the penetrations secured.
2. Impregnation tests, in which the specimens were treated with the preservative under pressure in a cylinder.
3. The Bulletin describes (a) tests made with mixtures of coal-tar creosote and coal tar from which the free carbon had been removed and similar mixtures containing varying amounts of free carbon; and (b) tests made with commercial coal-tar creosotes. The object in both cases was to determine the effect of penetration of differences in the preservative.

The scope of a report may therefore be indicated by the area involved; by the time consumed; by the quantity of material employed; by the number of units selected; by the character of the types chosen, or by the procedure adopted. There must be no doubt about the nature of the limits. Unless the boundaries are clear, a reader will be ill prepared for the task which lies before him.

CHAPTER 19

EXPERIMENTAL RESEARCH REPORTS—FUNDAMENTALS

Further Information Necessary.—The introduction, considered in Chapter 18, is by no means complete. References to purpose, importance, history, and scope are not sufficient to illuminate the text. To understand the procedure reported, a reader must be familiar with the materials, raw and manufactured, utilized in the research; with the apparatus employed in the investigation, with the theories on which the fundamental assumptions are based, and with the qualifications of those who have contributed to the success of the undertaking.

Materials.—Regarding the raw material, it is unnecessary to speak at length. It is customary to indicate explicitly quantity or number and quality or character in terms pertinent to the substances utilized. It is also customary to explain in detail the principles involved and the methods of selection adopted. Thus:

From *Comparison of Corn Oils Obtained by Expeller and Benzol Extraction Methods,* United States Department of Agriculture Bulletin 1054 (1922), by A. F. Sievers, Chemical Biologist:

(1)

METHOD OF SELECTING MATERIALS

In order to make a logical comparison of the oils obtained by both the expeller and the benzol extraction processes, it was necessary that both types of oil should be obtained from the same lot of germs. The material used in the experiments was obtained from typical hominy and glucose plants, the former producing dry-process germs and the latter wet-process germs. A day was spent in one plant of each type, and the material was collected, a little at a time, during a period of about seven hours. In this way approxi-

mately 15 pounds each of the germs and oil cake and about 5 gallons of expeller oil were obtained. This method of collecting the material gives reasonable assurance that the three types of oil

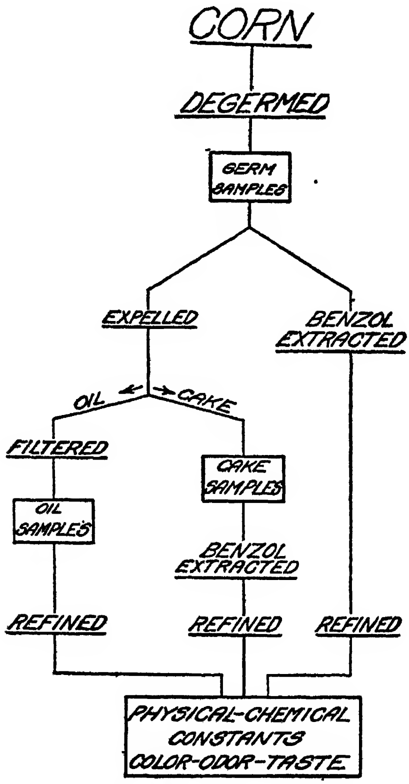

Figure 1. Diagram Showing the Method of Collecting Corn Material for the Extraction of Oil. This system was used in connection with both dry-process and wet-process germs.

—namely, the expeller oil and the oils extracted with benzol from the germs and from the cake—are derived from approximately the same germ stock. Figure 1 shows graphically the plan according to which the material was collected.

This passage corresponds exactly with the plan suggested. Not only are the quantity of germs and the amount of oil stated in terms of pounds and gallons, but the principle and method of selection are both described with sufficient definiteness.

Where manufactured material of any kind is utilized in the research, the character of the description is practically the same. Because of the intricacies of manufacture, however, the exposition is necessarily more minute. As in the following excerpt, it is invariably supplemented by a reference to the firms by whom the different pieces were produced.

From *Tests to Determine the Rigidity of Riveted Joints of Steel Structures:*

(2)

3. Description of Test Pieces.—The test pieces are shown in Figs. 2, 3, 4, 7, and 8, inclusive. Two pieces of each type were used, tests on similar pieces being made simultaneously.

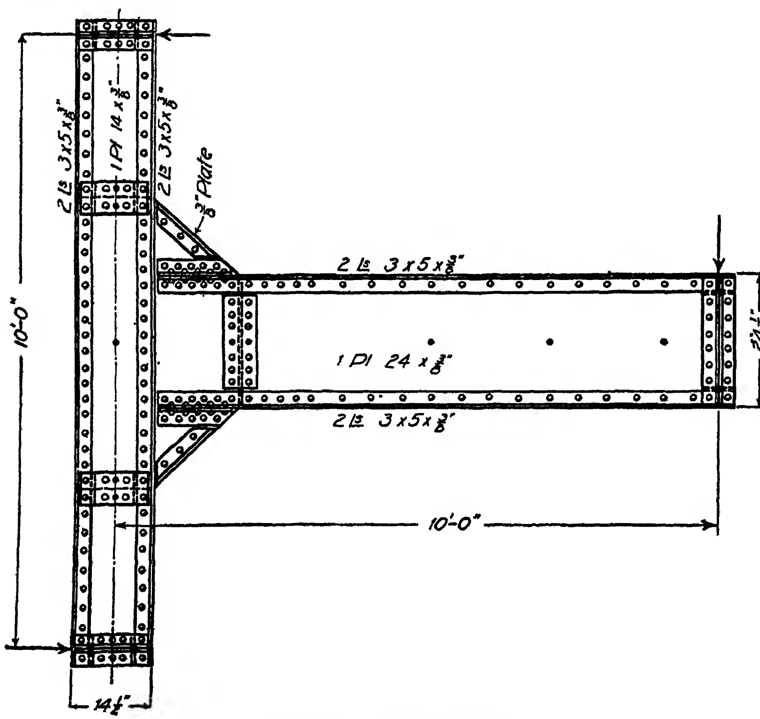

Figure 2. Test Piece A1

In selecting the test pieces, it was the aim to use connections of types which are common in engineering structures and which resist

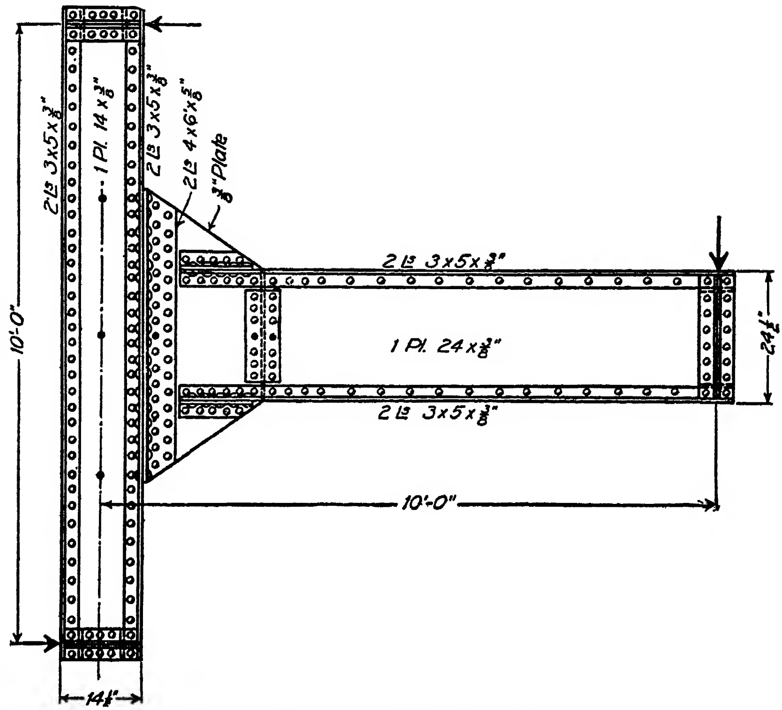

Figure 3. Test Piece A2

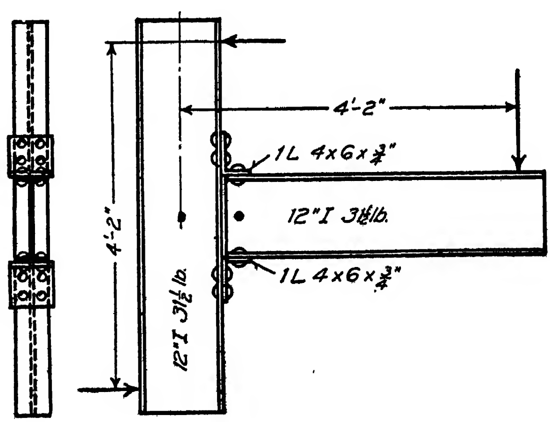

Figure 4. Test Piece A3

loads and moments which are fundamentally different. Test pieces A1 and A2 are types of connections used when the moment to be resisted is large; A4 is a type used when the moment is comparatively small and when the center lines of the columns and girders do not intersect; A3, A5, and A6 are designed primarily to resist shear and are not intended to resist moment. For all specimens except A1, relative rotation between the columns and girders can occur by virtue of the deflection of a comparatively thin member in cross-bending. In the case of A3, for example, the portion of the vertical leg of the top lug angle between the lower rivet and the

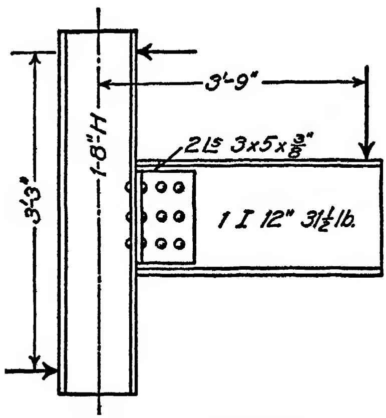

Figure 7. Test Piece A6

horizontal leg of the lug angle acts as a cantilever, and by bending the vertical leg the angle pulls away from the column. In a similar manner for A2, A4, and A6, bending of the outstanding legs of the connection angles permits the girders to rotate relatively to the columns. The connection of test piece A1 permits rotation of the girder relative to the column only by virtue of the axial strain in the metal or by virtue of the slip of the rivets.

Rivets which are usually driven in the shop were driven with a press riveter; rivets which are usually driven in the field were driven with an air gun. Test pieces A1, A2, and A3 were fabricated by the American Bridge Company; test pieces A4, A5, and A6 were fabricated by the Burr Company of Champaign, Illinois. The I-beams of A3 were used in making A4 and A6, and the girders and columns of A2 were used in making A5. The rotation of the girders relative to the columns in A4, A5, and A6 was due to

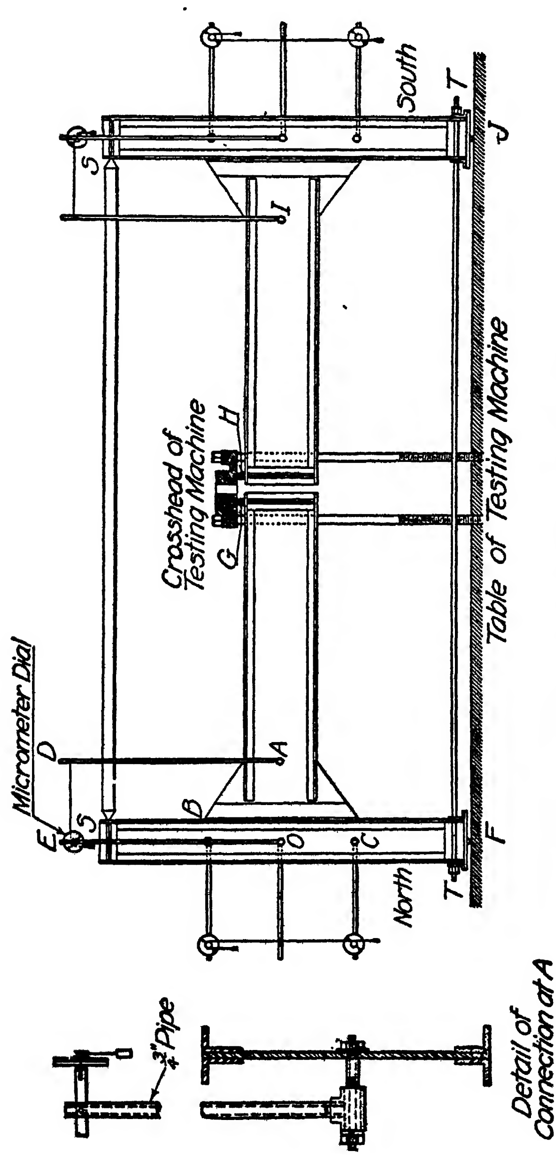

Figure 8. Diagram of Test Pieces in Testing Machine

the strain in the connection angles, and these connection angles had not been previously stressed. It is therefore improbable that the rotation of the girders relative to the columns in A4, A5, and A6 was affected in any way by the fact that the main members of which the test pieces were composed had been stressed as members of pieces A2 and A3.

The structural details of the girders and columns of the test pieces are given in Table 1 [omitted].

Because of the nature of the material, raw or manufactured, utilized in research, literal description is generally supplemented by graphic representation. As a rule, structural details can be explained most effectively by a series of diagrams.

Apparatus.—Although it may not be—and usually is not—necessary to describe in detail the material used in the course of an investigation, the apparatus employed requires careful consideration. Two distinct cases occur: first, where the mechanisms and machines are extant and familiar to the reader; second, where they are neither extant nor familiar and must therefore be constructed and afterwards explained.

Familiar Apparatus.—In the first case, all that is necessary is a definite reference to size, number, or arrangement. The extract from Mr. Odell's report is characteristic.

From *Coal and Coke Mixtures as Water-Gas Generator Oil*, Bureau of Mines, Technical Paper 284 (1921), by W. W. Odell:

(3)

The equipment used consisted of two U. G. I. 8-foot, 6-inch carbureted water-gas sets supplied with air and steam meters, pyrometer and column gauges. Views of these sets are shown in Plates I, A and B; A is a photograph taken from the operating floor and B is a photograph taken from the ground floor of the generator house.

With water-gas sets, as well as with meters and gauges, every reader is presumably acquainted. Photographs are introduced merely to indicate arrangement.

Unfamiliar Apparatus.—In the second case, the problem is more complex. The apparatus, perfected, as a rule, only after

A. Operating Floor of Generator Plant, Showing Two Carbureted Water-Gas Sets in the Foreground

B. Ground Floor of Generator House

a series of experiments, must be portrayed in such a way that its appearance can be easily visualized and its operation easily understood. Since a reader will be interested primarily in the essential characteristics and principles of the mechanism or machine with which the writer is dealing, description is usually generalized or typical, not specialized or particular. In some instances, however, details are important.

From *A Study of Contact Potentials and Photoelectric Properties of Metals in Vacuo: and the Mutual Relation between These Phenomena*, a doctoral dissertation at the University of Chicago, by Albert Edward Hennings.

(4)

Description of Apparatus

The apparatus designed for this study is enclosed in a glass bulb about 13 cm. in diameter with five projecting arms—four being in the horizontal plane and the fifth occupying a vertical position—the axes of all meeting at the center of the bulb. Fig. 1 represents a horizontal section in the plane of the intersecting axes of the two pairs of projecting arms, and Fig. 2 represents a vertical section in the plane including the vertical axis and that of one of the pairs of projecting arms. The horizontal arms are 42 to 45 mm. in diameter.

Eight metals, magnesium, aluminum, zinc, tin, iron, brass, copper, silver, in the form of disks 2 cm. in diameter are mounted upon an amber hub 38 mm. in diameter with the planes of their faces parallel to the axis of the wheel so formed. To one end of the rod passing through the hub, and supporting it by means of suitable bearings *b, b,* in brass tubes joined rigidly together and fitted firmly in the projecting arms of the bulb, is attached a double anchor-shaped piece of iron, m_1. By means of an external electro-magnet the wheel may be rotated, and, if necessary, moved a short distance along the axis, making it possible to adjust very accurately the position of any of the eight metal disks.

The longest of the projecting arms is fitted with a brass tube which is attached to, and holds rigidly together, the brass tubes which support the axle of the wheel. This tube serves to give support to the bearings for a rod carrying at its inner end a well-tempered wedge-shaped steel tool, *k,* 2 cm. wide, and, at two other points, the iron armatures m_2 *and* m_3. The latter by means of a

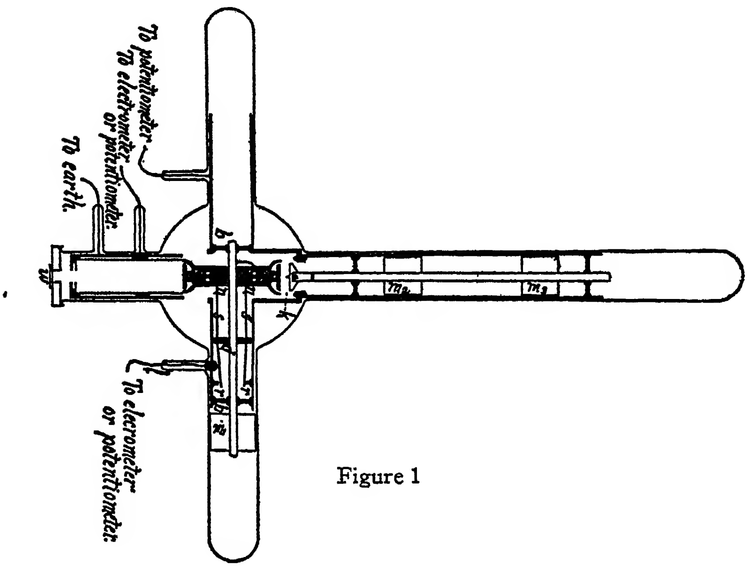

Figure 1

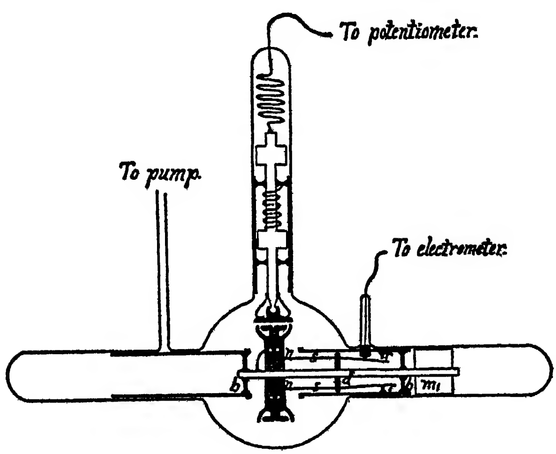

Figure 2

second external electro-magnet may be rotated and moved along the axis. The knife-edge is thus made to rotate and simultaneously to press against the surface of one of the metal disks brought into juxtaposition. By this device all of the eight metal surfaces were effectively scraped off in vacuo. With the softer metals, precaution had to be taken so as not to cut away too much. To insure the success of this device the knife carries at its middle point a thin conical projection which fits into a hole in the center of the disk.

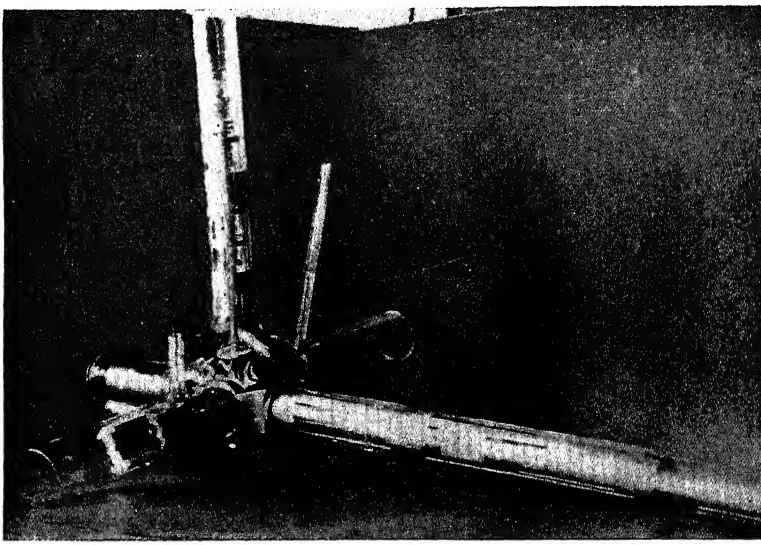

Figure 2a

In order that the knife may always bear upon the whole surface, the rod is jointed very near its inner end.

The shortest of the projecting arms carries a brass cylinder with an inner concentric, one of a double layer of fine meshed wire gauze. Both cylinders were blackened by oxidation and are insulated from each other with amber. The further end of the double cylinder so formed is closed save for a central circular opening 11 mm. in diameter through which ultra-violet light may be directed upon one of the metal disks when brought into such a position as to practically close the double cylinder at the inner end, which is open and as near the wheel as possible without interfering with its motion. The ultra-violet light is admitted through the thin quartz window, *w*, which closes a circular opening 9 mm. in

diameter in a heavy glass plate. Both the quartz and glass plates are sealed on with de Khotinsky cement. The outer brass cylinder was earthed in this work, and the inner one of gauze was used as the receiving electrode for the measurements of the photo-currents.

The metal under investigation is insulated from all the rest by means of the commutator arrangement now to be described. Leading from the brass nuts, *n*, into which the rods attached to the metal disks are screwed, are the heavy steel wires, *s*, one for each of the disks. The wires are held apart by the amber disk, *d*, which is fixed upon the axle of the wheel, and which causes the wires to press against an immovable ring, *r*, inserted inside the brass supporting tube. When the wheel rotates, each wire slides over and remains in contact with the inner surface of this ring except at two points in a complete revolution, one when the disk to which the wire is attached is in position for ultra-violet light illumination, and the other when it is in position for the measurement of the contact potential. (This latter position will be indicated, and the manner in which the measurement is made will be described presently.) At these two points the steel wire is forced to break contact with the ring by means of a curved piece of brass which is insulated by means of amber. The platinum wire, *l*, leading to the brass is then in communication with the now insulated disk. To insure the best possible contact, the curved piece of brass and the brass ring are faced with platinum, and each of the wires at the two points where contact is made is likewise covered with platinum. There is a second amber disk (omitted from the diagram to avoid confusion), placed near the end of the wires which is slotted radially and which serves to prevent each wire from being carried around by the friction between it and the surface with which it is making contact. The plate under illumination may be charged to various potentials, and the distribution of velocity curve determined by observing the rate with which the wire gauze cylinder used as receiving electrode charges up. This procedure was the one adopted for the major portion of the photo-electric data recorded in this paper. Measurements of the positive potentials acquired by the insulated plate when exposed to ultra-violet light were also made by putting the plate in communication with the electrometer and applying the accelerating or retarding potentials to the wire gauze cylinders.

The vertical arm supports by means of an inserted brass frame a spool-shaped piece of iron which carries at its lower extremity a brass plate 3½ cm. in diameter. A solenoid outside the tube is

used to raise or to lower the brass plate, which, with each of the metal surfaces in turn, constitutes the condenser system employed in determining the contact potentials. The metal disk which is to be examined when brought into position directly beneath the vertical tube is insulated by the commutator device already described. The two surfaces are brought near together by lowering the brass plate upon the three projecting arms which surround, but are insulated from, the disk. The plane of the points of these three arms was made as nearly parallel as possible to that of the disk and about .12 mm. (before the surfaces were scraped) above it. It is not essential that the two planes be absolutely parallel if for each combination the relative position of each of the surfaces when near together is always exactly the same. The brass plate must therefore never fail to rest upon all three points when lowered. This condition is met by having the brass plate upon a ball and socket joint. Between the rod above the joint and the back of the plate are attached also three brass springs, the purpose of which is to make certain that the movable plate is kept horizontal when it is being moved away from the disk beneath. A portion of the weight of the iron spool is borne by a spiral spring attached between it and the supporting frame in order that the solenoid need not be inconveniently large.

It has already been pointed out that the aim of such a description is to indicate the appearance of the apparatus and the principle of its operation. Two distinct methods of approach are therefore possible.

A writer may choose to emphasize appearance. If so, he will probably begin with a generalization regarding the mechanism or machine as a unit and afterwards enumerate the parts of which it is composed. This plan is followed by Dr. Hennings. The first paragraph contains a brief picture of the apparatus as a whole. The second paragraph deals with the eight metal disks. The third and fourth paragraphs treat the longest and shortest of the five projecting arms. The details mentioned are arranged according to their order in space. To relate details of this kind to one another in an harmonious *ensemble,* it is customary to emphasize a characteristic of the apparatus such as strength or stability to which they contribute.

On the other hand, a writer may choose to emphasize not appearance but operation. If so, he will probably begin with a

statement of the principle exemplified and then show, step by step, how each part of the apparatus functions. In the fifth paragraph, Dr. Hennings employs this method in explaining the commutator arrangement. Details like those mentioned are generally unified by insistence upon a quality such as ease or economy in operation.

Whether the description is approached from the standpoint of appearance or operation, or whether, as in Dr. Hennings' report, the two are combined, it may be supplemented by a literal comparison or graphic illustration.

An effective device is to explain what is complicated and unfamiliar in terms of what is simple and familiar. There are few mechanisms or machines which do not lend themselves to a comparison of some kind. For instance, the apparatus employed by Dr. Hennings at once suggests a cross with a fifth arm projecting perpendicularly at the point of intersection. To begin a description with such a contrast is often the most economical method of procedure. It establishes an outline which the writer can elaborate without danger of confusing the reader.

Even more important is graphic illustration, in which diagrams and photographs are both employed. Diagrams—line drawings which, as Dr. Hennings suggests in parenthesis, necessarily emphasize fundamentals only—are widely used. They may be treated as a demonstrator in a store treats the conveniences—the vacuum cleaner or the carpet sweeper—which he is trying to sell. As the demonstrator points, in explanation, to the salient features of these devices, so a writer, by means of legend and coincident lettering like that in Dr. Hennings' exposition, may point to the elements of the apparatus which he is describing. Although as a rule photographs are used only to convey general impressions, it is sometimes possible, with modern methods, to secure almost as effective a presentation of the elements of apparatus as with line drawings. In Paul Black's report of *An Investigation of Relative Stresses in Solid Spur Gears by the Photoelastic Method,* University of Illinois Engineering Experiment Station Bulletin 288 (1936), photographs are used exclusively, as will be seen from the following extract.

(5)

Description of Optical Apparatus.—The photoelastic apparatus consists of a 60-watt Mazda inside-frosted bulb as a light source, and a Leitz petrographic microscope adapted to photoelastic purposes. In Fig. 1 is shown the photoelastic appartus; A

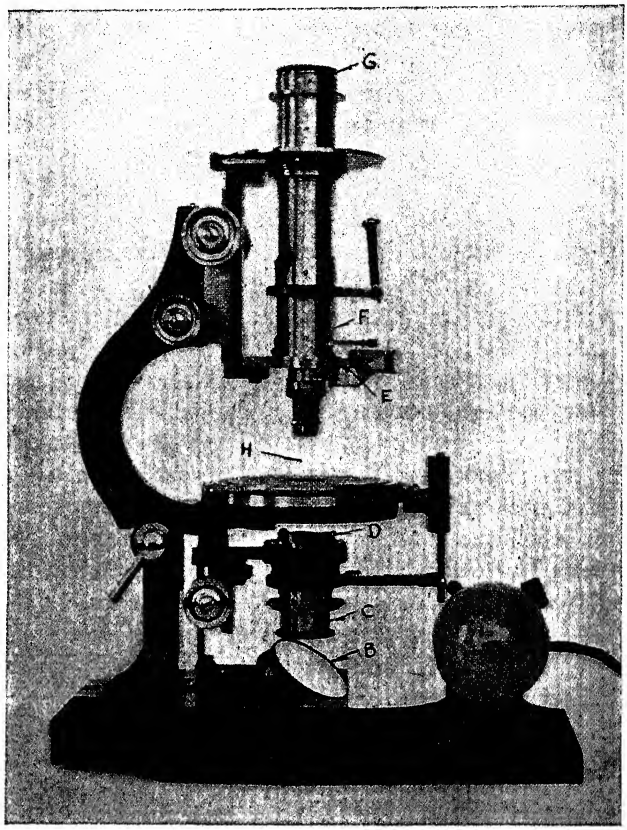

Figure 1. A Photoelastic Apparatus

is the light source; B is the reflecting mirror; C is the Nicol prism used as the polarizer; D is a quarter-wave-length plate mounted on a special holder on the microscope and at an angle of 90 deg. with E, the second quarter-wave-length plate, which is part of the standard equipment of the microscope; F is the second Nicol prism used as the analyzer, and was adjusted so that its axis made

an angle of 90 deg. with the axis of the polarizer; G is the eyepiece which contains cross-hairs; the transparent model to be tested was placed at H. Objective No. 1 and eyepiece No. 1 were used; this combination corresponds to a magnification of sixteen diameters.

Description of Loading Frame.—In Fig. 2 is shown the frame used for holding and loading the models of gears. The gears, which are made of transparent material, and which will be discussed in a following article, are 0.225 inches thick, and are

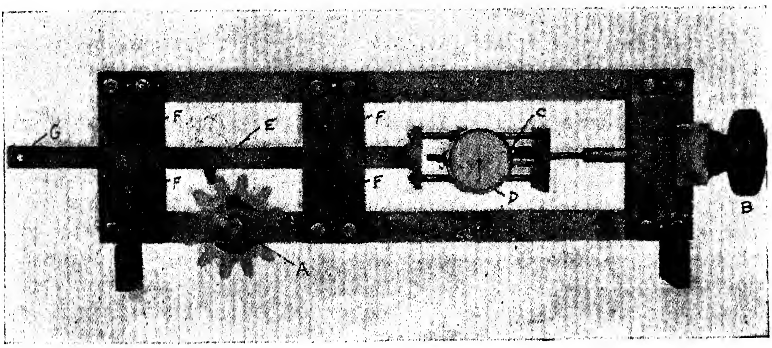

Figure 2. Loading Frame

fitted to steel discs 0.25 inches thick, each provided with a key, which are intended to represent the shaft on which the gear is mounted. Fig. 4 [omitted] shows a set of the pyralin models, Fig. 5 [omitted] the series of discs or shafts, each with its key, and Fig. 6 [omitted] two gear and shaft assemblies. As shown in Fig. 2, the gear and its shaft are mounted between two ¼ in. x 1 in. steel bars which comprise the lower rail of the loading frame. The shaft is held rigidly in place by the bolt at A in Fig. 2. The model, being slightly thinner than the shaft, will not be in contact with the steel bars. By turning the handwheel B, load is applied through the indicator springs at C. The dial gage D measures the deflection of the spring, and affords a means of determining the load transmitted by the spring to the bar E which runs between ball bearings located at F between the cross-bars. These bearings are adjustable by means of eccentric bushings. The bar E has a projection provided to apply load to a tooth of the transparent model. The face of this projection in contact with the model represents a rack tooth with an angle of obliquity of 14½

deg. Calibration of the dial gage was accomplished by applying known loads along the axis of the bar at point G. The spring calibration curve is shown in Fig. 7 [omitted].

Both diagrams and photographs should be placed close to the sections which they supplement. They should not be placed in the appendix.

Exercise: Description of Apparatus.—Describe, from the two points of view indicated, one of the following mechanisms or machines, most of which are to be found in university laboratories:

Air compressor; air pump; almucantar; ammeter; anemometer; autoclave; balance; bifilar variometer; blast lamp blowpipe; cathetometer; chronograph; combustion bomb calorimeter; condenser; Bourdon gage; conductivity bridge; coulometer; dynamometer; electric oven; electrometer; galvanometer; goniometer; hydraulic transfer jack; inductometer; injector; interferometer; jig; Jones flotation cell; lamp and scale; level; macroscope; mica condenser; microscope; microtome; muffle type roadster; ophthalmometer; Pelton wheel; permeameter; photometer; piezometer; planimeter; polarimeter; precision potentiometer; prismatic compass; prony brake; pulsating classifier; psychrometer; radio wavemeter; refractometer; reverberatory furnace; rheostat; saccarimeter; sextant; specific gravity flask; spectroscope; spherometer; steam still; sterilizer; synchronizing fork; tachometer; tapalog; telescopic alidade; theodolite; thermocouple; thermostat; transformer; transit; trommel screen; Venturi meter; Vernier caliper; viscosimeter; voltmeter; wattmeter; Wheatstone bridge.

Theories.—Hypotheses and formulas are often no less important than materials and apparatus. Hypotheses occur chiefly as abstracts. Formulas, which are concise generalizations used as short-cuts, appear as postulates or equations. If these postulates and equations are current, references to the processes of derivation are unnecessary. If, as often happens, they have been established by individual investigators and are known by their names, bibliographical data in the form of footnotes will be sufficient. For instance:

In *Dependence of Sound Absorption Upon the Area and Distribution of the Absorbent Material,* National Bureau of Standards Paper R.P. 700 (1934), by V. L. Chrysler, part of the "Introduction" deals with the theories and formulas underlying present-day calculations of sound absorption:

(6)

The acoustic qualities of a room in a large measure depend upon the rate at which sound energy in it decays. After a room is completed this rate of decay can be measured, but the problem which must be solved, is, how to design a room so one is sure what its acoustic qualities will be after it is built.

The rate of decay of sound energy has been measured in many different kinds of rooms which were used for many different purposes. In general if the room is properly designed and the absorbent material properly placed so as to prevent echoes, flutters, etc., and if it has a given rate of decay, it can be predicted whether or not it will be acoustically satisfactory for a given use, as for example, an auditorium or business office.

To know in advance of construction that a room will be acoustically satisfactory requires, therefore, that we know how to compute this rate of decay from the geometrical dimensions of the room and the acoustical properties of the materials used in its walls, ceiling, and floor, and in addition the acoustical properties of the furniture and other contents of the room. In attempting to solve this problem it is customary to make acoustical measurements of various materials, furniture, etc., in a reverberation chamber, and then, using a formula to compute certain numerical coefficients for the materials, furniture, etc., which will aid us in making the necessary prediction.

The formula most commonly used, for surfacing materials, is the "Sabine formula":

$$T = \frac{.05V}{a_1 s_1 + a_2 s_2 + \ldots}$$

where T is the reverberation time (in seconds); i.e., the time required for the sound to decay to $\frac{1}{1{,}000{,}000}$ of its original value, V the volume (in cubic feet) of the room (or sound chamber), $s_1, s_2 \ldots$ the areas of the different surfaces (in square feet), and $a_1, a_2 \ldots$ are called the sound absorption coefficients of these surfaces and $a_1 s_1 + a_2 s_2 \ldots$ is called the total absorption of the room (or chamber). Although in practice the process is simplified by a "calibration" of the chamber, in theory, the determination of the "absorption coefficient" of a surfacing material would consist in measuring the rate of decay of sound in the

reverberation chamber with and without the presence of a known area of the material. From the two reverberation times so measured and the known dimensions of the chamber, the absorption coefficient would then be determined by substituting in the formula.

To determine what effect a combination of materials would have in a room, the absorption coefficients so determined are substituted in the same formula using the volume of the room and the respective areas as given by the design. The reverberation time computed in this way is expected to give some idea of the reverberation time which the room would have after it is constructed.

In deriving this formula certain assumptions are made as follows:

(1) The reflected sound energy flux over any portion of the surface is a definite fraction ($1\text{-}a$) of the incident sound energy flux, where a is defined as the absorption coefficient of the material.

(2) The sound absorption coefficient of a material is independent of the intensity of the sound.

(3) The sound energy flux incident upon the boundary surfaces of the air space enclosed in the room or chamber is uniform over all the boundary surfaces, or in other words there is a diffuse distribution of sound energy.

Here the writer has merely summarized the principles upon which the investigation depends, substantiating his generalizations by reference to the proper authorities. At times, however, the premises on which the hypotheses are based must be expressly established. Under such circumstances, especially where the derivations are long or complicated, the solutions are usually placed in the appendix. There seems to be no more reason for including them in the text than there is for including in it an account of the experiments through which the apparatus was evolved. Wherever they are inserted, the form sanctioned by experience—the custom of giving to each formula or equation an independent line—is invariably adopted.

In *The Plastic Flow of Concrete*, Ohio State University Engineering Experiment Station Bulletin 91 (1935), by J. R. Shank, a section entitled "General Nature of the Phenomenon" presents in simple language the present theories:

(7)

The best picture of what goes on inside a piece of concrete when shrinkage or plastic flow takes place seems to be that given by Messrs. Davis, Davis, and Hamilton* of California, who in turn refer to Lyman** of England. "In general, there appear to be three ways in which continuous yielding may take place. First, there may be a movement of particles one over the other, as in the flow of oil, asphalt, glue, or wet clay; this may be called *viscous flow*. Second, in a mass composed of crystals, slip may occur along planes within the crystals. This type of yielding, which in metals is called 'creep' will be called *crystalline flow*. The third way in which yielding may occur is by an actual loss of liquid from a mass composed of a liquid and a finely divided solid; this action will be called *seepage*, the term used to describe the phenomenon in colloidal systems."

It is generally known that the hydration of portland cement starts by the formation of a gel around each cement particle. This gel formation continues until the entire particle is hydrated. The time for this process varies greatly, depending upon the size of the particle, the nature or the composition of the particle, the presence of retarders, and the presence of water; it is believed by some that the gel in time changes over into crystalline forms. The plastic flow appears to be largely due to the compression of this gel. Lyman demonstrates that the fundamental cause of variations in volume, whether due to moisture conditions or pressure, is the movement of water into or out of the gel.

Viscous flow or creep, though probably present in some cases, may hardly be considered as of great importance in comparison to seepage, because the nature of the composition and structure of portland cement concrete indicates that very little viscous flow can take place except as the gel may act as an oil-like component. One test made at Ohio State University in which ground glass coarse aggregate and crushed glass fine aggregate were used showed a decided departure from the usual action. From 12 to 33 days after loading, the rate of plastic flow was about double that observed up to 12 days. After 33 days the former rate, or a little less, was again resumed. This all took place without any reduction of the load or any apparent rupture of the specimen. Apparently some special type of plastic flow, possibly viscous flow or

* "Plastic Flow of Concrete Under Sustained Stress," by R. E. Davis, H. E. Davis, and J. S. Hamilton, *Proc.* A.S.T.M., Vol. 34, Part II, p. 354.

** *Growth and Movement in Portland Cement Concrete*, by C. G. Lyman, Oxford University Press (1934).

crystalline flow, at the aggregate surfaces may have taken place. A short investigation showed that the glass itself at ordinary temperatures had no appreciable plastic flow, though the action of fatigue was abundantly demonstrated. The erratic behavior of this ground glass aggregate specimen may be due to many local failures at the aggregate surfaces which by the action of autogenous healing re-bond or again cement themselves to the surface after the movement has taken place.

Compared with the mathematical interpretation in the previous selection, Mr. Shank's treatment is less detailed and more continuous. One of its chief merits is its readability. As the experimental report is likely to become a medium for popularizing the results of scientific research as well as for transferring them from one specialist to another, a summary of this character is certain to become increasingly significant.

Personnel.—Finally, personnel must be considered. At times references to those who have aided in an investigation is little more than an act of courtesy in acknowledgment of an obligation incurred. Thus, John David Mackenzie, in *The Geology of Graham Island, British Columbia,* a doctoral dissertation at the Massachusetts Institute of Technology, mentions his assistants, the residents of the Island, and the members of the department under whose direction the study was prepared. These comments, however, are matters of taste rather than necessity. They belong to the etiquette of scholarship—conventions of no great significance except as revelations of personality which few can afford to neglect.

(8)

ACKNOWLEDGMENTS

The writer wishes to express his appreciation of the assistance rendered him by the various members of his field parties, who cheerfully collaborated in work which was almost always laborious, often disagreeable, and at times dangerous. To the many residents of Graham Island, who by their interest and encouragement furthered the work, he is also grateful. Thanks are due to the members of the Department of Geology at the Institute for their frequent advice and criticism during the preparation of the report.

With this general acknowledgment of indebtedness—similar to that in an examination report—may be compared the specific statement of Edward C. Schmidt and Herman J. Schrader in *The Friction of Railway Brake Shoes, Its Variation with Speed, Shoe Pressure, and Wheel Material,* University of Illinois Engineering Experiment Station Bulletin 257 (1933):

(9)

5. ACKNOWLEDGMENTS.—This investigation was undertaken as one of the coöperative researches of the Engineering Experiment Station of the University of Illinois, in coöperation with the Association of Manufacturers of Chilled Car Wheels, of Chicago. The University and this Association shared the expense of the tests.

In accordance with the general practice of the Experiment Station in such investigations, the scope of the tests and the general test program were defined by an Advisory Committee on which the Association was represented by Mr. G. E. Doke, President, Mr. F. K. Vial, a Director and Consulting Engineer, and by Mr. E. C. Edwards, Travelling Engineer of the Griffin Wheel Company; while the University was represented by Professor Edward C. Schmidt and Mr. Herman J. Schrader. Toward the end of the investigation, Mr. Doke's place on the committee was taken by Mr. H. C. Van Buskirk, Executive Vice-President of the Association.

The conduct of the tests, the calculation and analysis of the data, and the preparation of the report were under the exclusive control of the Railway Engineering Department of the University, which acted for the Experiment Station and which assumes full responsibility for the validity of the tests and the results.

Special acknowledgment is made of the part taken in this work by Mr. Clifford E. Morgan, who was appointed Special Research Assistant for the purposes of this investigation. Under the supervision of Mr. Shrader, Mr. Morgan prepared the shoes and wheels, operated the testing machine and shared in the reduction of the test data. His unflagging zeal and resourcefulness contributed greatly to the accuracy and uniformity of the results. Mr. Robert H. Newell, a graduate student in railway engineering, also shared in the calculation of the results.

As previously stated, this research has been a part of the work of the Engineering Department of the University of Illinois, of

which Dean M. S. Ketchum is the director; and of the Department of Railway Engineering, of which Professor Edward C. Schmidt is the head.

Definiteness in this case is not only a courtesy but also a guaranty that the research has been conducted under competent direction and that the staff has been adequately trained. Where there has been collaboration, the allotment of duties is an essential topic. Especially in reports on commercial undertakings the names of assistants are needed to fix responsibility. A lawsuit may often hinge upon these facts.

Variations in Arrangement.—Though the elements which have been discussed appear in the introduction to most experimental reports, the order is not necessarily the same. While the scheme suggested is followed at times with mathematical rigidity, the parts are often transposed and blended to form a single prefatory unit. It may be well, for example, to begin with a reference to the importance of the subject or to a development which has aroused more than passing interest. In fact, success depends largely upon a writer's skill in maintaining and yet obscuring the outline formulated in these chapters.

In *A Study of Contact Potentials and Photo-Electric Properties of Metal in Vacuo* are references to inception, purpose, importance, plan, scope, and history:

(10)

Three years ago Professor Millikan suggested as a promising subject for research the careful study of the contact potential differences between metals in vacuo under conditions which would eliminate the effects of surface films. He considered it imperative that such a study be undertaken both because of the light which it ought to throw on the true nature of contact potentials and because his own photo-electric studies had produced evidence that the positive potentials acquired by metals under the influence of ultra-violet light were very probably related in some definite, but not yet fully understood, way to the contact potential differences between the metals. After carrying on preliminary experiments for a year or more with different types of tubes, the writer decided upon the experimental arrangement and designed the apparatus which has been used in the work herein reported.

The plan in brief was to test, simultaneously and in vacuo, the contact potentials and photo-electric properties of eight of the ordinary metals not only under conditions which have usually obtained in the study of either of these phenomena, viz., with surfaces prepared in air and subsequently surrounded by a vaccum, but also with surfaces mechanically prepared in a vacuum which was the best obtainable, and which was maintained throughout all operations; and, finally, to observe the time changes in contact potential differences and photo-sensitiveness of photo-electrically or mechanically treated surfaces.

So far as I am aware, no experiments have been made heretofore on the contact potential differences between metal surfaces freed from gas or oxide films. The chemical theory of contact potentials makes the whole effect depend essentially upon the existence of such films. Hence the significance of experiments of this kind upon the theory of contact potentials. Photo-electric experiments on clean surfaces in vacuo, however, have already been made and described by Pohl and Pringsheim, and Hughes,* using freshly distilled surfaces, and by Hermann,† Richardson and Compton,‡ and Page,** using mechanically cleaned surfaces.

* Roy. Soc. Phil. Trans., 212, pp. 205-226.
† Verh. d Deutch. Phys. Ges., 14,557, 1912.
‡ Phil. Mag., 24, pp. 575-594.
** Amer. Jour. Sci. 26,501, 1913.

In *Impact and Static Tensile Properties of Bolts,* National Bureau of Standards Research Paper R.P. 763 (1935), the authors, H. L. Whittemore, G. W. Nusbaum, and E. O. Seaquist, combine introduction, references to interest and importance, history and literature, purpose, scope, and assistance:

(11)

Bolts are used in machines and structures to fasten together parts which cannot readily be made of one piece, or parts which may be removed for adjustment, cleaning, or repairs. In many cases these fastenings are subjected in service to static and to impact tensile loads. The designing engineer should know not only the greatest load which a bolt will sustain without failing but also the work (force times distance) required to rupture the bolt if, under unusual circumstances, the bolted structure should be subjected either to steady or to impact loads greater than the working loads for which the structure was designed.

The resistance to static loads depends upon the tensile strength of the bolt with nut. The resistance to impact loads, however,

depends upon the work required to rupture the bolt under suddenly applied loads. This "impact work" depends upon the load-stretch curve under impact. This will be different from the load-stretch curve under static conditions and would be affected differently by the shape and surface of the threads and the character of the material.

Many investigations have shown that for metals under either tensile or transverse loading, the work required to rupture the specimen under loads applied slowly (the "static work") is not equal to the work required to rupture it under loads applied suddenly (the impact work). Similar differences between the static work and the impact work are to be expected for bolts.

A few investigators have studied the static and, sometimes, the impact strength of bolts. Their results were used as a guide when preparing the test program for this investigation. The effect of decreasing the cross-sectional area of the shank of the bolt to about the cross-sectional area at the bottom of the threads has been discussed by Kimball and Barr.[1] They point out although decreasing the cross-sectional area lowers somewhat both the torsional and the tensile strength and the stiffness, it increases the impact work many times because it increases the stretch. They discuss decreasing the cross-sectional area by reducing the diameter of the shank, by longitudinal flutes and, preferably, by an axial hole. Drop tests upon bolts for Professor Sweet's straight line engine showed that the impact work was increased about nine times by an axial hole.

The effect of differences in the pitch of the thread was studied by Major William R. King, U. S. Engineers.[2] His static tensile tests made at Watertown Arsenal on wrought-iron bolts, 1½ in. diameter having V threads, showed that the static work for bolts having 18 threads per inch was four times that for similar bolts having 6 threads per inch.

The shape of thread was considered by Langenberg.[3] His tensile impact tests at Watertown Arsenal on specimens having Acme threads (flat bottoms) showed greater stretch and greater impact work than similar specimens having a semicircular groove at the bottom of the thread.

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[1] *Elements of Machine Design*, p. 178 (1913).

[2] "Experiments with Bolts and Screw Threads," *Trans.* Am. Inst. Mining Engrs. 14, 90 (June, 1885, and May, 1886).

[3] "Investigation of Failure of Elevating Screws on 14-in. D.C. No. 13 and 14-in. D.C. No. 14," *Tests of Metals*, p. 44 (1917). "Experiment Data Obtained on the Charpy Impact Machine," *Tests of Metals*, p. 222 (1918). Also this latter paper by F. C. Langenberg, Bul. Am. Inst. Mining and Met. Engrs., No. 152, p. 1471 (August, 1919).

Beyer [4] made static tensile and tensile impact tests on cold-drawn steel bolts having Dardelet and U. S. Standard threads. He reported that bolts having Dardelet threads gave greater static tensile strength, greater stretch, and greater resistance to impact than similar bolts having U. S. Standard threads.

He found further [5] that the static tensile strength and the static work depended upon the length of the thread exposed between the head of the bolt and the face of the nut. As the length of exposed thread was decreased, the stretch under static load and also the static work decreased markedly being only one-half to one-third as great when no threads were exposed as when the exposure was two or three times the diameter of the bolt.

To keep this investigation within practicable limits it was decided to study the effect on the static work and impact work of differences in only three variables. They were the shape of the thread, the material, and the size of the bolt. The three shapes of thread which are used for most commercial bolts in this country were chosen. They were the American National coarse thread, the American National fine thread, and the Dardelet thread. The differences between the American National coarse thread and the U. S. Standard thread, and between the American National fine thread and the SAE thread are so small that there is no reason to believe that there would be appreciable differences in the static or the impact works. Therefore, the U. S. Standard thread and the SAE thread were not included. The results showed the effect of differences in the pitch for threads having the same profile (shape) as studied by King and the effect of differences in the profile of commercial threads as studied by Langenberg and Beyer.

The materials, chromium-nickel steel, cold-rolled steel, monel metal, bronze, and brass, were chosen as representative of the kinds of material which are used for commercial bolts and nuts. It is believed that from the results on these five materials, the static work and the impact work for other materials can be estimated with sufficient accuracy for engineering purposes. If all the different materials used for bolts and nuts had been included the cost of this investigation would have been prohibitive.

Through the courtesy and coöperation of the Ordnance Department of the U. S. Army the impact tests were made in the large

[4] Reports No. 2162 (Nov., 1929) and No. 2162A (Feb., 1930), "Comparative Shock Resistance of Standard V Thread and Nut Connections and Dardelet Thread and Nut Connections." Columbia University (New York, N. Y.)

[5] Report No. 2207 (June, 1930), "Effect of Length of Thread Exposure upon the Static Tensile Strength and Energy to Rupture of Standard V Dardelet Thread and Nut Connections," Columbia University (New York, N. Y.).

Charpy machine at Watertown Arsenal. This machine [6] having a nominal capacity of 2,170 ft.lb. (300 kg.-m.) is the largest impact machine of the Charpy type in this country. Nisley gives the weight of the pendulum as 212.46 lb., the radius to the center of gravity as 5.34 ft., the maximum starting angle as 160°, the free return angle corresponding to the maximum starting angle as 158°, the velocity of impact (maximum starting angle), as 28.65 fps., the (actual) capacity as 2,203.2 ft.-lb., the distance from the center of the specimen to the axis of rotation as 6.56 ft., the period of oscillation as 2.77 seconds, and the weight of the block or tup as 5.07 lbs.

For some of the materials it was estimated that specimens of the desired shape having a diameter greater than ¾ in. might not be ruptured in this impact machine. It was estimated, therefore, that in this machine bolts made from the strongest and most ductile material and having a diameter of ¾ in. could be tested and that the results obtained on bolts made from the weakest and least ductile material and having a diameter of ⅜ in. would be sufficiently accurate.

As bolts having a diameter of less than ⅜ in. are seldom used under severe service conditions, the sizes chosen for the specimens were ⅜, ½, ⅝, and ¾ in. diameter.

To avoid differences in work found by Beyer [7] caused by differences in the length of thread exposed between the head of the bolt and the face of the nut, all the tests were made with the thread exposure equal to one diameter of the bolt. It is believed that this is about the average thread exposure for commercial bolts under service conditions.

[6] Harold A. Nisley, "The Relation Between the Dynamic and the Static Tensile Tests," Army Ordnance 4, No. 20, 88-93 (September-October, 1923).

[7] Report No. 2207 (June, 1930), "Effect of Length of Thread Exposure upon the Static Tensile Strength and Energy to Rupture of Standard V and Dardelet Thread and Nut Connections," Columbia University (New York, N. Y.).

These two excerpts should make clear the fact that a successful introduction is not a stereotyped affair. As the experimental report becomes more definitely responsive to the canons of art, the prefatory elements are certain to be more skilfully shaped and more generally fused into a single harmonious unit.

CHAPTER 20

EXPERIMENTAL RESEARCH REPORTS—DEVELOPMENTS

Course of the Investigation.—Having read the introduction, a reader should be able to follow the course of the investigation. To make his way absolutely clear, a statement of the procedure adopted may be included in the report. A general explanation, based on sound psychological principles, is certain to make it easier for him to understand the experiments and the results which they precede. These experiments and results will determine its character. Often it appears inevitable. For instance:

In *A Chemical Study of the Ripening and Pickling of California Olives,* United States Department of Agriculture Bulletin 803 (1920), by R. W. Hilts, Chief of Western Food and Drug Inspection District, and R. S. Hollingshead, Junior Chemist, the "Plan of Investigation" is so logical that it seems almost a matter of course.

(1)

As it does not appear that any systematic study has been made of the ripening of olives in California, the plan of this investigation was first to follow the development of the fruit on marked trees, recording changes of composition and physical characteristics, especially color, in order to establish, if possible, the differences between immature and ripe fruit, and to ascertain how closely the color of the fresh fruit is related to, or may indicate, maturity. This was done for different varieties and localities, and during successive seasons, to show the influence of these factors. In the second place, to make the data applicable to the finished product, different lots of olives were followed through the pickling process to find what changes occur in the composition and color.

Without confusing their readers by unnecessary detail, the writers offer to them in brief compass a panorama of the whole

investigation. Any student with imagination can see at once how they proceeded. If he knows nothing at first hand about olives, and wants to be concrete, he can substitute apples and think in terms of the Baldwins and Spies in his father's orchard or on the experimental farm at college.

So, in *A Study of the Heat Transmission of Building Materials,* University of Illinois Engineering Experiment Bulletin 102, by A. C. Willard, Professor of Heating and Ventilation, and L. C. Lichty, Research Fellow, where the conclusions are based upon a number of distinct tests, the methods employed in each series are described by a few bold strokes:

(2)

IV. Testing Methods and Equipment

9. Methods.—The equipment or apparatus for making heat transmission tests in building materials varies according to the method of testing and the data desired. Some excellent laboratory plants have been designed for making heat transmission tests, and some of the most elaborate of these have been used abroad.*

The methods most commonly employed in this country may be classified, according to principle at least, as follows:

(1) Ice Box Method
(2) Oil Box Method
(3) Cold Air Box Method
(4) Hot Air Box Method
(5) Flat or Hot Plate Method

* Arthur K. Ohmes, "A Notable Institution for the Advancement of the Heating and Ventilating Art," *Journal A. S. H. and V. E.,* Vol. 22 (January, 1916).

Each method is then explained.

Procedure for Each Experiment.—As it is advisable to indicate in a general way the course of an investigation, so it is advisable to explain the conduct of each experiment. The illustrations below may be linked with those of the preceding section.

From *The Composition of California Lemons,* United States Department of Agriculture Bulletin 993 (1921), by E. M. Chase, Chemist in Charge, and C. P. Wilson and C. G. Church, Assistant Chemists, Laboratory of Fruit and Vegetable Chemistry:

(3)

METHODS OF ANALYSIS

Unfortunately, in order to make a satisfactory determination of the essential oil of the fruit, it was necessary to divide the sample. After the specific gravity of the fruit had been determined by weighing in the air and under water, this division was made as evenly as possible, both as to size and color. Half the sample was ground by being passed through a food grinder three times, and the oil was determined in a portion of it by steam distillation, according to the method of Wilson and Young.* The acidity of the whole fruit was determined on another portion of this sample by titration with alkali solution, using phenolphthalein as indicator.

* C. P. Wilson. "The Manufacture of Citric Acid from Lemons," *Calif. Citrograph*, 6:110 (1921).
C. P. Wilson and C. O. Young. "A Method for the Determination of the Volatile Oil Content of Citrus Fruits," *J. Ind. Eng. Chem.*, 9:959-961 (1917).
[These references appear in the bibliography of the report.]

In *Investigation of Bell and Spigot Joints in Cast-Iron Water Pipes,* Ohio State University Engineering Experiment Station Bulletin 87 (1935), by John C. Prior, the holding power of well-constructed joints was tested by means of the apparatus pictured in Figure A.

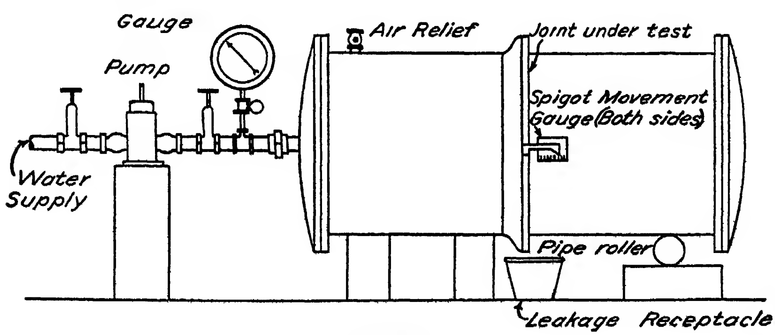

Figure A

Professor Prior describes his tests as follows:

(4)

In general the testing procedure was as follows: After the pipes were filled with water, the air being completely excluded, the pressure was raised by increments. The increment size varied with the pipe size, being larger for the smaller pipes. Between each pressure

increment, until the spigot piece showed a measurable movement, a time interval of three to five minutes was ordinarily allowed.

When the first slip occurred, the pressure was held constant until all movement of the spigot ceased for a period of 10 min. or longer. In a few tests the pressure was reduced immediately following the first slip. To follow this procedure on soft-lead joints of the larger sizes requires time and patience. In some instances . . . the spigot, although under constant pressure, slowly and irregularly moved during a period of three or four hours. Each succeeding rise in pressure was similarly treated until complete failure of the joint occurred.

During the tests the movements of the spigot were accurately measured at frequent intervals. These intervals were not shorter than one minute and generally not longer than five. Measurements were taken on both sides of the pipe in a horizontal plane through the center-line and were made with a scale which was easily read to 1/32 in.

The leakage from these joints, where leakage occurred, was carefully caught and measured at convenient intervals. The accumulated leakage is reported in cubic centimeters. The rate of leakage at any time may be obtained from the mass curve of leakage. . . .

The aim of all such explanations is to show definitely how the materials and apparatus previously described are employed in each experiment. In the passage quoted above, the writer deals not only with the manipulation of these two elements, but also with the time allotted to each test, with the kind and number of readings taken, and with the nature and extent of the series run. These points cover most of the facts usually included in this section of the report.

Exercise: The Procedure in an Experiment.—Write a brief exposition of the method employed in one of the tests or experiments required in a laboratory course which you are attending.

Interpretation of Experiments.—After the kind of preparation which has just been described, it ought not to be difficult for a reader to appreciate the significance of the experiments. In interpreting them, several points should be kept in mind. To begin with, it should not be forgotten that in all probability they are steps in a process and that the natural order is

therefore chronological. On the other hand, in many studies temporal sequence is of little moment. In reality, however, this distinction is of slight importance. It does not influence form perceptibly. In both cases, tests must be sharply differentiated from one another. Consequently, it is advisable to accentuate their independence by some kind of numeration. If they fall into a number of separate series, they may be grouped accordingly as A 1, 2, 3, 4 . . . and B 1, 2, 3, 4. . . . A grouping of this character, expediting references to individual analyses, contributes materially to the clearness and conciseness of the report. The gain in clearness may be heightened by reverting to a principle which has been stressed in connection with the text as a whole—parallelism. The use of a few experiments as types under which others that fall into similar categories may be listed also adds to the conciseness of the treatment. Any divergence from the norm can be explained by a mere statement of variation. In each instance, results are expressed as tables or equations arranged as coördinates. Summaries of those in different series are useful in the comparisons which must often be made in formulating the conclusions to the research.

Arrangement of the Conclusions.—The conclusions are the essence of the report. As seen in the extracts from *Smoke Abatement* and from *Employee Thrift and Investment Plans,* they consist of the facts established by the investigation. These facts may be presented independently in tabular form or interpreted in the light of other phenomena.

(5)

110.07. Conclusions to be Drawn with Reference to the Extent to which Smoke Discharges from Metallurgical and Manufacturing Plants Pollute the Atmosphere of Chicago.—This study of the results of the Committee's numerous tests and analyses made in connection with the investigation of smoke discharges justifies the following conclusions with reference to the extent to which the smoke discharges from metallurgical and manufacturing plants constitute a source of atmospheric pollution:

1. Metallurgical and manufacturing plants consume 22.36% of the total amount of fuel and 98.6% of the coke consumed within the city limits of Chicago, ranking third as a fuel consuming service and first in the consumption of coke.

2. Metallurgical and manufacturing plants are responsible for 28.78% of the total visible smoke discharged within the city limits of Chicago.

3. Metallurgical and manufacturing plants are responsible for 64.26% of the total solid constituents discharged into the atmosphere in the smoke of all services within the city limits of Chicago.

4. Metallurgical and manufacturing plants are responsible for 76% of the total mineral matter discharged into the atmosphere in the smoke of all services within the city limits of Chicago.

5. Metallurgical and manufacturing plants are responsible for 21.13% of the total gases of combustion discharged into the atmosphere in the smoke of all services within the city limits of Chicago.

6. Steel plants, foundries, forges, and allied processes are responsible for about 98% of both the solid constituent of smoke and the gaseous constituents of smoke from all metallurgical and manufacturing plants within the city limits of Chicago.

In most experimental reports, the conclusions are arranged formally in this manner. As here, each conclusion appears as a separate paragraph consisting, usually, of a single sentence. Paragraphs, too, are coördinated by parallelism and numeration. As a rule, no comment is necessary.

In dealing with themes such as profit sharing, in which opinion often clashes with fact, and in which results are more or less imponderable, a hard-and-fast scheme is seldom advisable. Treatment is therefore informal, as the "Summary" (Chapter V) of a study made by the National Industrial Conference Board entitled *Employee Thrift and Investment Plans* (New York, 1929) indicates:

(6)

It has been shown in this study that the basic purpose of employers to assist members of their working force to acquire a financial surplus has become fairly general, but finds expression in a wide variety of forms. From the simple type of plan in which the employer acts as hardly more than a passive intermediary between the bank and the employee, to the comprehensive investment trust in which a committee representing management and employees invests a fund consisting of the aggregate savings of many, there is an indefinite number of variations in form and in methods of administration.

Probably the most general form of savings plan is that which provides for regular, authorized payroll deductions by the employer, who turns over the amount deducted to a savings institution for crediting to the individual accounts of participants in the plan. Bank books may be held by the company or by the employee, withdrawals may or may not be made through the employer, the savings fund may run for an indeterminate period or may mature at the close of a fixed period. There may be any number of variations upon the main theme, but all plans of this character are readily recognizable as belonging to the same general group.

A second and more pretentious type of plan aims to bring to the employees the full investment return from their combined savings. Usually by means of authorized payroll deductions, a fund is accumulated which is invested by a committee chosen for the purpose, and periodic dividends are declared on a pro rata basis. This method offers the wage earner a more lucrative investment for his savings than the deposit of them in a savings bank, since dividends of from 6% to 8% are frequently paid. Such plans are dangerous, however, unless rigidly supervised by men who are financial experts. Injudicious investments resulting in loss of employees' savings can do incalculable harm. A plan of this character is better not undertaken unless means are available for its sound administration.

The third main group of plans for stimulating thrift combines savings with the privilege of borrowing, and includes as its main divisions credit unions and building and loan associations. The introduction of this borrowing feature makes these plans of double benefit to the employee, and helps to solve one of the most difficult problems of domestic financing on small incomes. Not only do these plans provide the means for borrowing small amounts to meet special emergencies, but they also permit long-term financing for home ownership.

In any or all of these plans, provision may be made for assistance in the form of contributions to the savings fund on the part of the employer. In some cases the employer pays an extra interest dividend on what the employee saves, while in other instances an amount equal to a certain proportion of the savings may be added to the fund, or a more general contribution to the aggregate savings fund may be made on the basis of a share in the profits of the company or on some other basis. While such contributions undoubtedly add to the attractiveness of the savings plan, they are not necessarily essential to its success.

Employers generally seem to be satisfied that their sponsorship of these thrift plans is a step in the right direction. The benefit to the employee of a savings fund which can be relied upon for emergencies or for old age is obvious. But the employer also realizes a gain in a reduction of the petty annoyances associated with granting personal loans or advances on wages, and, in a broader and much more important way, gains in the improved morale of his working force.

The feeling that prevailed to a certain extent in an earlier generation—that a working force not entirely dependent upon current earnings was likely to get out of hand—has largely disappeared, to be replaced by the conviction that the worker who possesses some property in the form of a home or bank account has a greater respect for his employer's property and becomes a more reliable and more permanent asset to the company.

Beyond and above the immediate advantage of these savings plans to employer and employee is their social significance. Any agency which can make a person of small income less likely in time of emergency to be forced to choose between privation and charity is a benefit to the community. A citizenship with an increasing proportion of persons with even limited financial independence is likely to manifest a respect for law and for the property of others which makes for stability. Therefore, employers who are assisting their employees to free themselves from complete dependence upon current earnings are performing a genuine service to society.

However, the operation of a savings plan, of whatever character, leaves the employer more open to criticism from certain sources than many other features of an industrial relations program. A plan for assisting employees to set aside a part of their earnings lends itself well to distortion into the appearance of an attempt to control every cent the employee earns. This consideration has deterred the managements of some companies from introducing a savings plan and in other cases has prevented the effective development of the full possibilities of the plan. As has been shown, employers are loath to give the appearance of interfering with the individual employee's disposition of his earnings. This raises one of the most serious difficulties in the satisfactory conduct of a savings plan. It is clear from figures shown earlier that under ordinary conditions the mere introduction of such a plan falls far short of realizing its greatest possibilities. Present spending is too attractive to be overcome by an abstract advantage to be realized in an indefinite future. A stimulus to thrift is necessary, but it is difficult

for the average employer to know when such a stimulus may take on the appearance of compulsion.

In many plants the relationship between employer and working force is so free from suspicion that the sponsorship of a savings plan by the employer is natural and raises no question. In other cases, outside influences or other factors may cause interpretations to be placed upon the introduction of such a plan which are entirely without foundation but none the less unfortunate in results. In such cases there appears to be the choice of avoiding any appearance of dictating by merely providing the mechanics of a savings plan in case some employees wish to avail themselves of it, or of actively teaching the value of thrift and offering encouragement to build up a savings fund, disregarding whatever criticism may be aroused. The second method actually carries no more compulsion than the first. The difference lies simply between selling the principle of thrift or trusting that it will sell itself.

The evidence shows that the encouragement to thrift on the part of employees is assuming considerable proportions. There is no reason to believe that this movement will not spread. In its more advanced forms, carefully administered, it offers a safe investment outlet for the savings of individuals, which may do much to add to their financial welfare and spare them the disillusionments of ill-advised ventures into high finance. . . .

As in the case of any industrial relations activity, no one form of thrift plan is equally applicable to all conditions. The size of the company, the prevailing type of employees and other considerations must be taken into account in deciding upon the plan best calculated to meet a given set of circumstances. Neither is it necessary to put into operation at the outset as comprehensive a program as may be contemplated as the ultimate goal. A simple savings plan may be elaborated as conditions warrant into a more pretentious program which adds to the facilities for savings other means for investment and for short and long term loans. In every plan for assisting the employee to save, the security of the worker's principal must be the paramount consideration, the *sine qua non* of all plans for extending and elaborating upon the savings program.

In this instance the writers make no attempt to formulate definitely by a tabular arrangement the results of their researches. Their conclusions are tentative only. The report concludes with the remark that "The evidence shows. . . ." As they properly should be, most of the statements are hedged

about by reservations such as this, "no one form of thrift plan is equally applicable to all conditions." The final sentence is as close as the report comes to a general conclusion. As is evident, in such a study a rigid mathematical interpretation of the facts would be unwarranted and perhaps dangerous.

Position of the Conclusions.—The logical position for the conclusions resulting from an investigation is at the end of the text. A better plan, however, especially in reports which are to be read by laymen, is to place the conclusions immediately after the introduction or foreword. The General Motors Corporation follows such a plan, as Dr. C. F. Kettering, president and general manager of the General Motors Research Corporation, indicates in a brief paper, "The Importance of English to the Engineer in Industry," *Journal of Engineering Education,* N. S. XXVII: 442-443 (January, 1937):

(7)

After years of trying different methods of preparing reports, we have developed a procedure which makes it possible for everyone interested in the work to get the information he is after. On the first page, we start with a short foreword which explains, in general terms, the subject and reasons for the investigation. The second page contains the conclusions: concise and to the point. For the busy engineer or executive, the whole story is on the first two pages.

Although the writer of an experimental report can be certain that the expert for whom it is intended will be interested in the soundness of his methods as well as in the character of his results, and though he can be certain also that the expert, unlike the business man, will not be tempted to glance at his findings and then cast aside the premises for a convenient hour that may never come, the practice of reiteration has much to recommend it. If the investigation is prolonged or complicated, a brief review of the facts on which they rest may be inserted before the conclusions at the end of the text.

Suggestions for Other Researches.—Since a research may lead to avenues which the investigator himself cannot explore because of lack of time, equipment, or money, it is well to indi-

cate them for others; to suggest, in brief, what remains to be done Sometimes it may even be well to recur to the historical review, and, in a short paragraph, to sketch the status of the subject at the beginning of the study; to survey the work just completed and to summarize it in a similar paragraph; and, finally, as in the extracts below, to examine the gaps that remain and to emphasize the need for specific explorations. A résumé of this character, linking together past, present, and future, is a valuable legacy.

From "Study of Stilling-Basin Design," *Transactions* of the American Society of Civil Engineers for 1934, by C. Maxwell Stanley:

(8)

NEED OF FURTHER RESEARCH

In conclusion, the writer wishes to urge further research on this problem. The effect of submergence upon the capacity of a given basin to dissipate energy should be studied further. In studying the effects of the shape of a dam, various slopes as well as various constructions at the toe should be investigated. A series of experiments to determine the resulting scour below the weir for various basins, proportioned from the data included in this paper, would be desirable. Experimentation to determine what part of the basin requires a concrete floor to prevent erosion within the basin should also be made. Such research will lead to additional data of value in establishing a rational method of designing protective devices for overflow dams.[1]

To determine in this way the research which remains to be carried out in a particular field is often quite as important as any specific result. Indeed, an investigation which merely establishes the character of the facts needed is sometimes more valuable than any other. An historic instance illustrating the usefulness of such a stock-taking is Bacon's *Sylva Sylvarum,* which contains suggestions for a thousand special studies. Its influence upon the development of science in the seventeenth century far outstripped that of any work done by Bacon himself.

[1] Reprinted by permission of the American Society of Civil Engineers.

Appendix and Index.—Of the elements described in Chapter 2, only the appendix and the index have not been considered in this discussion of the experimental report. Because this type is a closely articulated unit, the parts of which are interdependent, and because, therefore, it is not likely to be read piecemeal; because it is seldom as long as the information, the examination, or the recommendation report, and because, therefore, a reader can generally turn at once without inconvenience to the section containing a particular point at which he may wish to glance, the index is usually omitted. The appendix, however, has a definite function to perform. It contains bibliographies, notes, statistics, charts, and exhibits as well as references, problems, and quotations likely to interrupt the continuity of the text. In no other type of report is its supplemental character more obvious.

Form of the Bibliography.—As indicated in Chapter 15, a list of the books and articles consulted during an investigation is an essential part of an experimental report. For a book, the data required are the title, number of volumes, edition, and place and year of publication; for an article in a periodical, the title of the extract and that of the weekly, monthly, or quarterly in which it is to be found, and the date—the day of the week or the month as well as the year—of issue. The volume in which the selection appeared and the pages at which it begins and ends are sometimes noted. Since every magazine contains a table of contents with due pagination, these facts are relatively unimportant. More fundamental are those regarding proceedings and transactions illustrated by the bibliography from *Smoke Abatement* printed below.

In continuous prose, italics are employed to indicate titles of books, and quotation marks to indicate titles of articles. At times, as in the excerpt selected for illustration, quotation marks are used to indicate both. At present there is an evident tendency to eliminate, as unnecessarily mechanical, all typographical distinctions and to rely upon completeness of information and clarity of arrangement. This plan is followed in the bibliographical references used by the writers of research reports for the National Bureau of Standards.

From *Smoke Abatement:*

(9)

BIBLIOGRAPHY

In the following pages is presented a complete list of the published articles, books, pamphlets, reports, and treatises studied by the Committee in connection with the several investigations concerning smoke abatement and air pollution as covered in its report.

Atwater, C. G. "Smokeless Fuel for Cities, Its Relation to the Modern By-Product Coke Oven." Cassier's Magazine, Vol. 30, p. 313. May-Oct., 1906.

Bailey, G. H. "The Air of Large Towns." Science, Vol. 22, p. 197, 1893.

Bailliere, Henri "Les fumées dans Paris." (Smoke in Paris.) Annales d'hygiene publique et de médicine légale, 3d Series, Vol. 41, p. 288, 1899.

Barr, Wm. M. "Combustion of Coal and Prevention of Smoke." New York, 1904.

Baskerville, Chas. "The Smoke Problem and the Community." Journal Industrial and Engineering Chemistry, Vol. 2, p. 355, 1910.

Bayles, James C. "Gas Leakage and the Public Health." Domestic Engineering, Vol. 24, p. 161, 1902-03.

Bean, J. W. "A Note on Recent Observations of the Smoke Nuisance at Kew Gardens." Paper read at the Smoke Abatement Conference, London, March, 1912.

Beard, J. T. "Carbon Monoxide in Mines." Mines and Minerals, Vol. 27, p. 276, 1907.

Beck, K. "Determination of Sulphuric Acid in Storage Battery Rooms." Chemical Abstracts, Vol. 4, p. 2247, Aug.-Dec., 1910.

Becker, H. "Akkumulator-Doppelwagen fur die Preussische Staatsbahnverwalting." (The Storage Battery Double Car of the Prussian Government Railway Administration.) Electrische Kraftbetriebe und Bahnen, Vol. 7, p. 265, 1909.

Behre, Otto "Klima von Berlin." (Climate of Berlin.) 1908.

Beilby, George — Presidential Address. Journal Society of Chemical Industry, Vol. 18, p. 643, London, 1899.

"Suppression des fumées des foyers industriels et des foyers domestiques d'après le discours de M. Beilby, Président du Congrès de la Societié anglaise de l'industrie chimique." (Suppression of the Smoke from Industrial Furnaces and Domestic Fireplaces according to the Address of Mr. Beilby, etc.) Revue Industrielle, Vol. 30, p. 367, 1899.

Benedict, Francis Gano — "The Composition of the Atmosphere with special reference to its Oxygen Content." Carnegie Institution, Washington, 1912.

Abbreviations in the Bibliography.—The typographical differentiation between books and articles mentioned in the preceding section is of relatively slight interest. Articles are usually of supreme importance. In many bibliographies, therefore, they alone appear. If it is necessary to mention the same periodical a number of times, space and, consequently, expense can be saved by using an abbreviation sanctioned by usage or fixed by the writer. An economical method is to place before the bibliography a list similar to that below.

From *Report on Photoelectricity,* National Research Council Bulletin 10 (1921), by Arthur Llewelyn Hughes, Research Professor of Physics, Queen's University:

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Abbreviations for Journals

P. R. ....Physical Review
P. N. A. S.......Proceedings of the National Academy of Sciences
A. P. J..........Astrophysical Journal
J. O. S. A.......Journal of the Optical Society of America
J. A. C. S. ......Journal of the American Chemical Society
P. M. ....Philosophical Magazine
P. R. S..........Proceedings of the Royal Society of London
P. L. P. S.......Proceedings of the London Physical Society
A. d. P..........Annalen der Physik

P. Z. .... Physikalische Zeitschrift
V. d. D. P. G..... Verhandlunger der Deutsche Physikalische Gesellschaft
Z. f. P.......... Zeitschrift für Physik
C. R............ Comptes Rendus

Types of Bibliographies.—The older type of bibliography, arranged alphabetically by author, as in the extract from *Smoke Abatement,* is still common in reports which attempt to treat any subject at all exhaustively. In such bibliographies the usual abbreviations are employed, although in every field there are individual conventions in the matter of form. The following portion of a bibliography from *The Quantitative Determination of Lead by the Electrolytic Deposition of Lead Dioxide,* Bulletin of the School of Mines and Metallurgy of the University of Missouri (1935), by Thomas Gordon Day, Philip Hall Delano, and W. T. Schrenk, is typical:

(11)

Weiser, H. B., Hydrous Oxides of Lead, The Hydrous Oxides. McGraw-Hill Book Co., New York, 1926, p. 231.

Westerkamp, A., Electrolytic Estimation of Lead in Tin Alloys and in Tinned Iron. Arch. Pharm., Vol. 245, 1907, p. 132.

White, A. J., Simultaneous Determination of Copper and Lead with the Rotating Anode. Trans. Amer. Electrochem. Soc. Vol. 24, 1913, p. 297.

Wichman, H. J., Report on Metal in Floods. Jour. Assn. Off. Agricultural Chem. Vol. 17, 1934, p. 197.

At present there is a tendency to arrange items in the order in which they occur as references in the text. The obvious disadvantage of this arrangement, which is followed in many research reports and papers in the fields of science and engineering, is that articles by particular authors are not easy to find without searching through the entire bibliography. An example (page 22), from *The Use of Syenites in Semivitreous Ware,* Ohio State University Engineering Experiment Station Bulletin 94 (1937), by C. J. Koenig, follows. In form and arrangement it is typical.

(12)

1. I. L. Sills, "Minerals and Mineral Products Used in the Glass Industry," Can. Mining Met. Bull., No. 267, pp. 365-87 (1934); Ceram. Abs., 13 (9) (1934).
2. A. N. Dauvalter, "Slag Nepheline Glass," Keram. i. Steklo, 9 (3) 26-27 (1933); Ceram. Abs., 12 (9) 325 (1933).
3. S. N. Solovianov, "Using Nepheline in Glass Manufacture," Chim. & Ind., 26 (3) 631 (1931); Ceram. Abs., 11 (1) 15 (1932).
4. Samsonow, "Use of Nepheline in 'Proletary' Glasswork," Ceramics and Glass, 7 (3) 3 (1931); Ceram. Abs., 10 (10) 688 (1931).
5. V. V. Wargin and N. K. Matvejev, "Defects of Nepheline Glass," Ceramics and Glass, 7 (3) 5 (1931); Ceram. Abs., 10 (10) 687 (1931).
6. Klein, "Constitution and Microstructure of Porcelain," Bureau of Standards Tech. Paper No. 80 (1916).
7. Herbert Insley, "The Microstructure of Earthenware," Jour. Amer. Ceram. Soc., 10 (5) 317 (1927).
8. A. B. Peck, "Effect of Time and Temperature on the Microstructure of Porcelain," Jour. Amer. Ceram. Soc., 2, 175 (1919).

Another type of bibliography found in reports is one in which the material is classified and arranged by content rather than by author. Such bibliographies are useful in discovering the material available on a given subject. They are arranged by topics, with alphabetical author or subject arrangement under each heading, as in the two appendices, Number 4 and Number 5 of the report, *Headwaters Control and Use* (Washington, D. C., 1937), published by the United States Department of Agriculture, or they may be arranged alphabetically throughout, as in the following example from the "Report of the Committee of the City Planning Division on Street Thoroughfares Manual," of the American Society of Civil Engineers, published (pp. 1076-1078) in the *Transactions* for 1935:

(13)

ELEVATED HIGHWAYS FOR CHICAGO, COMPARED TO STREET WIDENINGS, *Engineering News-Record,* April 27, 1933.

EQUITABLE DISTRIBUTION OF BENEFIT ASSESSMENTS, by Hyman Shifrin, M. Am. Soc. C. E., *Civil Engineering,* March, 1933, p. 158.

EXCESS CONDEMNATION IN CITY PLANNING: A Symposium (Paper No. 1585) *Transactions,* Am. Soc. C. E., Vol. 89 (1926), p. 791.

EXPRESS HIGHWAYS IN FRANCE (Editorial), *New York Times*, November 4, 1930.

THE EXPRESSWAY IN THE REGION, by Robert Whitten, *City Planning*, June, 1932.

FINANCING STREET AND HIGHWAY IMPROVEMENTS (Paper No. 1828), by R. W. Crum, M. Am. Soc. C. E., *Transactions*, Am. Soc. C. E., Vol. 98 (1933), p. 74.

GRAPHIC REGIONAL PLAN, Regional Plan of New York and Its Environs, Vol. 1, (1929).[2]

Outline of a Typical Experimental Report.—The elements of the experimental report may therefore be summarized briefly as follows:

I. PREFACE
 1. Title Page. A glance at the material, the writer, and the reader.
 2. Table of Contents. A topical outline indicating the substance of the main divisions.
 3. Abstract. A summary showing the character and result of the investigation. This summary should make it possible to determine immediately the nature of the report. In practice, it has replaced the letter of transmittal, which seldom appears except as a matter of departmental routine.

II. TEXT
 1. Introduction
  A. Object. Definition.
   (a) Object. A concise statement of the aim of the study.
   (b) Definition. An explanation of the terms that may require limitation.
  B. Importance. History. Scope.
   (a) Importance. A reminder of the significance of the subject and a note, if needed, on the utility of the investigation.
   (b) History. A survey of the progress in the field considered, with appropriate references to important books and articles.

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[2] Reprinted by permission of the American Society of Civil Engineers.

These references should be supplemented by footnotes, which must be complete and accurate, or by a bibliography arranged in proper form.

(c) Scope. An indication of the range of the study.

C. Material. Apparatus. Theory. Personnel.

(a) Material. An enumeration of the substances utilized.

(b) Apparatus. A description of the mechanisms and machines employed.

(c) Theory. An explanation of the principles involved or the premises accepted.

(d) Personnel. A reference to those who have been connected with the research.

2. Procedure

A. General. A synopsis of the plan of investigation.

B. Particular.

(a) Experiment. An exposition of the laboratory routine.

(b) Result. A presentation and an interpretation of the phenomena observed.

3. Conclusion. A summary indicating the facts established. Suggestions regarding supplementary investigations may be useful.

III. Appendix

1. Notes. References.
2. Statistics. Computations.
3. Charts. Exhibits.

Order of Elements in the Report.—At this point a word of caution may be necessary. Although it seems advisable to summarize in this way the elements of the report, what has been said regarding the arrangement of the introduction is applicable to the text as a whole. There is no fixed order. An outline should be a guide and not a tyrant. Every writer should be captain of his course. The buoys by which he must set it, however, are those which have been charted here. If he follows them, he is not likely to go astray.

Research reports presented as undergraduate theses, or prepared for publication in scientific or technical periodicals, are usually organized in three main divisions:

1. Introduction
2. Experimental Procedure
3. Results and Conclusions.

Within these divisions are grouped, sometimes in the form of single sentences, the various elements included in the outline above.

Students who are preparing research reports will do well to examine the forms established by the editorial committees of the various national societies and the bulletins issued by the research agencies in the fields in which they are working. Many of these are cited in this volume.

Proportion in the Report.—In another respect, also, the outline may be misleading. In it little space is devoted to the experiments on which an investigation depends. Nevertheless, they are infinitely more important than the phases of the introduction. Though it is possible to indicate, in a general way, the methods of research applicable to a particular subject, success, after all, depends upon the initiative of the investigator. "There is very little difference between one man and another when you get to the bottom of it," said a workman to William James, "But what little there is, is very important." In an investigation what counts is the little difference in daring and originality between the man who leads and the man who follows. It is this flash of daring and originality which gives to any report its final significance.

Problems of the Experimental Report.—The kind of subject treated experimentally has been suggested in Chapter 17. The extracts selected for illustration should make clear their character. In the first place, many materials possess properties, reactions, and uses which are not yet understood. Some of the ways in which they may be manipulated have been indicated in this chapter. In the second place, numerous organisms, occasionally so minute that they cannot be seen even through a

microscope, possess powers and characteristics which are still unknown. In the treatment of such topics, laboratory technique often deals with methods of generation, stimulated, it may be artificially, and with the actions of these organisms under specific conditions.

Most physical and biological problems are obviously matters of research. On the other hand, in the fields of economics, sociology, and education, the accumulation of fact is not greatly different from that required for an examination report. The aim, however, is not to discover and to correlate a series of isolated data but to establish a number of generalizations which will be accepted as contributions to the fund of human knowledge. In research of this sort, a factory, a school, or a geographical unit may become a kind of laboratory; and the experiences of individuals, their actions and reactions, serve as experiments from which certain conclusions can be drawn. The routine of investigation is thus being brought to bear upon social and industrial as well as upon scientific and technical phenomena. In this development, the scientist and the engineer, both trained in the technique of research, ought to play no inconsiderable part.

Readers of the Experimental Report.—As yet, the experimental report is largely the property of specialists. It is written by experts, and it is addressed to them. Many important discoveries have therefore remained in the possession of small groups working in separate fields. Unfortunately, too, the masses have never acquired the familiarity with scientific methods and the mastery of logical processes which they might now be applying to their daily concerns if the results of research had been presented to them with the clarity and charm of Huxley's "On the Physical Basis of Life" or "On a Piece of Chalk." There appears to be no reason why the experimental report cannot be divested at times of its technicalities and made a pliable and attractive means of public education. It is even conceivable that an investigator gifted with imagination may take the scheme outlined in this chapter and mold it into an artistic unit of universal significance.

Significant ventures in the field of popularizing the work of scientific experts are those undertaken by two news agencies, Science News Service and the Science Service of the Associated Press. They have shown that the public is interested in the results of research when they are attractively presented and that it is possible to deal with the varied aspects of science in language which an intelligent layman can understand. The air of mystery with which many writers of research reports surround their methods and findings is contrary to the rules laid down by the founders of the first great research organization among English-speaking peoples, the Royal Society, as recorded by Bishop Sprat, its earliest historian:

(14)

There is one thing about which the society has been most solicitous; and that is, the manner of their discourse: which unless they had been very watchful to keep in due temper, the whole spirit and vigor of their design had been soon eaten out by the luxury and redundance of speech. . . .

They have therefore been most rigorous in putting in execution the only remedy that can be found for this extravagance, and that has been, a constant resolution to reject all the amplifications, digressions, and swellings of style, to return back to the primitive purity, and shortness, when men delivered so many things, almost in an equal number of words. . . .

Experimental and Recommendation Reports.—Practically every experimental report, whatever its origin or character, now appears as a monograph addressed to specialists. Where the investigation has been undertaken for business reasons, and where, as in most industrial establishments, the results are submitted to a non-technical executive, the conclusions reached are usually presented in the form of a recommendation report. An expert employed in a plant laboratory who has been asked to solve a specific problem often, therefore, prepares two reports, one intended for his fellow specialists, who will challenge every step in his work, and the other for the directors of the firm, who will be content with his findings. Under such circumstances, the recommendation report consists of the facts estab-

lished and the exhibits submitted in illustration or verification. A statement regarding the length and cost of the investigation is sometimes added. Anything more is ordinarily out of place.

Exercise: An Experimental Report.—Submit, in the form of an experimental report, a thesis required as part of the regular work in one of the courses which you are attending. Since a research of any value consumes a great deal of time, you will not find it profitable to undertake one for the mere practice of reporting it.

CHAPTER 21

THEORETICAL RESEARCH REPORTS AND DESCRIPTIVE RESEARCH REPORTS

The Experimental Report a Basis of Exposition.—As pointed out in Chapter 17, the descriptive report, the theoretical report, and the experimental report were evolved in the order in which they are mentioned here. Of the three types, the experimental report is the most complex. Since nearly all problems which arise in connection with research have been discussed in the four chapters devoted to this type, the treatment of the remaining types, which can be referred to it, will require much less space. The theoretical report, which preceded immediately the experimental report, will be considered first.

The Theoretical Report.—The theoretical report follows exactly the plan of the experimental report. Whether it is developed literally, as in *A Report on the Quantum Theory of Spectra* (London, 1920), by L. Silberstein; or mathematically, as in *The Quantum Theory*[1] (Washington, D. C., 1920), by Edwin Plimpton Adams, Professor of Physics, Princeton University, it contains most of the elements described in the last four chapters. The preface, consisting of a table of contents and an abstract, is exactly the same as that of an experimental report. Nor does the text diverge greatly from the norm indicated. The introduction at least ought not to cause difficulty. It includes a statement of the purpose of the investigation, a definition of the terms employed, a note on the importance of the research, a review of previous studies, and an indication of the limits set by the writer. Since the theoretical report usually deals with ideas toward which men have been groping for years, perhaps even for centuries, an abstract of earlier contributions is essential. From this summary are drawn the hypotheses

[1] National Research Council Bulletin.

which are weighed and analyzed in the report. The premises consist, therefore, of the results reached by other investigators; and the conclusions depend upon the logical manipulation of these results. In general, the only difference between the theoretical report and the experimental report is that the former is not concerned with materials, apparatus, and methods.

The Descriptive Report.—The descriptive report, the most primitive of the three types, shows a natural difference in technique from either of the other two. In fact, the order of steps outlined in Chapter 17 is practically reversed. Library work necessarily follows field work. Not until his discoveries have been made can an investigator turn with profit to the literature of his subject. After he has turned to it, he will find that there must be a decided shift in the emphasis placed upon the sources usually employed in making a bibliography and preparing a historical review. In this connection, several points must be kept in mind.

Use of Catalogs.—In addition to the card catalog invariably found in American libraries, another type, the "specialist's catalog," is of great importance in a descriptive research. Instead of containing references to books and articles only, this type also contains numerous data regarding the animals or plants of a particular region or period. A compilation of this kind intended for experts in economic biology would include the names of the species and those of the scientists who discovered them; the titles of the articles and the numbers of the periodicals in which the discoveries were announced; the facts concerning the haunts and habits of the individuals or groups characterized; those concerning the parasites which prey upon them and the diseases which attack them; and, finally, those concerning the preventives used in combating them if they are injurious and the methods employed in utilizing them if they are beneficial. The merits of such a record are obvious. If one organism responds to violet rays in a particular manner, a similar response by another organism is sufficient to suggest a possible relation between the two. Numerous checks of this character may be applied in fixing a new classification or revising an old one.

Use of Bibliographies.—As a rule, bibliographies are of more aid in descriptive than in experimental researches. Since priority is of great importance, any record of previous investigations, however incomplete or antiquated it may be, is useful in establishing the nomenclature to be employed. Even a scanty list, seemingly out of date, may contain the facts desired.

Use of Notes.—Theoretically, the notes to be found here and there in books and articles should be of considerable value. Actually, because they are generally scattered and hard to discover, they are of little help.

Use of Indexes.—On the other hand, indexes to periodicals are of prime importance. Often it is difficult to determine which of two monographs is to take precedence. Under such circumstances, it may be necessary to fix the exact day on which each was published. In fixing it, magazines are occasionally decisive.

Evaluation of Literature.—In determining the value of the literature upon the subject in hand, the four touchstones—material, moment, manner, and man—mentioned in Chapter 17 are always applicable, although their relative importance is not necessarily the same as in an experimental research. The material, which may include both description and classification, is sometimes determinative and sometimes not. Ordinarily an expert has no difficulty in deciding whether the description is accurate. About the classification, however, even an expert can never be certain. Since it represents a personal opinion, it must always be accepted with caution. Moment and manner then become significant. Where nomenclature is concerned, the date of a monograph and the form in which it is cast are sometimes a sufficient index of its value. In addition, however, certain "rules" have been established by a convention which no one who claims to be a scholar can ignore. Any deviation from the norm is likely to reflect upon his learning and to nullify the result of his labor. Personality cannot be overlooked. Although of great importance in matters of opinion and conclusion, the questions regarding age, training, achievement, and reputation suggested in Chapter 17 are far from decisive in the

case of nomenclature. Nevertheless, even here, recognition is always a desideratum. When an investigator has become accepted as an authority upon a group of animals or plants, his work is naturally used as a basis of comparison. At best, however, reliance upon others is a dangerous practice.

Reports in the Biological Sciences.—What has been said in the last five paragraphs regarding the library work required in connection with descriptive reports applies to all the subjects with which they deal. In addition, however, these subjects, which may be drawn from either the physical or the biological sciences, lead to a number of distinct problems. The subjects drawn from the biological sciences, for example, fall into four distinct groups which are reflected in the arrangement of the reports in which they are treated. Since these reports are more common and, in certain respects, more significant than those upon subjects drawn from the physical sciences, they will be discussed at this point.

The first of the four groups of reports which have been mentioned is concerned with the methods applicable to the specific problems with which biologists are accustomed to deal. Reports of this kind are reports on *technique*.[2] The second group of reports is devoted to the description of animals and plants for purposes of determination and classification. Work of this nature is called "systematic biology," and the reports in which it is recorded are defined as *taxonomic*. The third group of reports is concerned with the conditions under which animals and plants live. Such reports are really studies in environment. In them, attention is focussed not upon the forms, which are often neglected as such, but upon the factors which influence them and the processes which result from their impact. Work of this nature is called *ecology*. The fourth group of reports may be contrasted with the second. As the taxonomic report deals with the unity of a species, which is represented by a type description, the fourth group deals with the variations in a species. To these variations, which are described in exact scientific language, it assigns distinct numerical values. Work

[2] See, for example, *Research Methods in Forest Environment*, United States Department of Agriculture Bulletin 1059 (1922), by Carlos G. Bates, Silviculturist, and Raphael Zon, Forest Economist.

of this nature is called *biometrics*. Each of the four groups of reports will be considered in detail.

Reports on Technique.—Because of their value to biologists, reports on methods have been placed first. The form which they have assumed may be illustrated by the order adopted in reports on anatomical and histological technique. The arrangement of the text is not hard to follow:

I. Review. A résumé of advances in technique, with a reference, possibly, to the need for increased knowledge.
II. Material. A note on the substances, gross or fine, commonly treated.
III. Technique. An exposition of methods employed when the material is
   1. Gross: Preparation and dissection.
   2. Fine: Fixation, imbedding, sectioning, and staining.
IV. Description. An explanation of the instruments used.
V. Illustration. A graphic representation of both methods and instruments.
VI. Significance. An estimate of their value.

This scheme, which is practically that adopted by physicians and surgeons, may be employed in reporting an individual study dealing with organs or tissues and involving operation or treatment. Under these circumstances, the report falls into three main divisions. The first consists of an introduction indicating the origin of the case; the second, of a description characterizing the organs or tissues examined and the instruments or methods used; the third, of a graphic representation supplementing the previous sections.

Exercise: A Report on Technique.—Prepare a report on tissue selection by stains.

Taxonomic Reports.—The second and most common kind of descriptive report in the biological sciences is that used to describe and to classify a plant or an animal. The text assumes the following form:

I. Introduction

1. Origin. A statement, similar to that in an experimental report, regarding the purpose of the study, the character of the work done by others, and the need of amplification or correction.
2. Scope. An indication of the limits—species, genus, class, etc.—fixed by the writer.
3. Definition. A glossary of any terms that are new or uncommon.
4. Technique. A note upon any methods that are unique or unusual. Ordinarily such a note is required only when the forms are microscopic.
5. Acknowledgment. A reference to those who have aided the author. If the identification of a species has been made by someone else, this fact should be stated. In such a statement, courtesy titles such as *doctor* and *mister* are invariably omitted. Unless indebtedness is distinctly personal, they are never employed.

II. Classification

1. Nomenclature. An explanation of the system of classification, with whatever comment on priority is required. The taxonomic position of the group treated in the report should be made clear by relating it to a type established according to current practice. The name of the founder, which is usually written in full without initials, should accompany the original description. If the classification has been changed, the name of the author should be placed in parentheses and supplemented by that of the scientist responsible for the transference.[8] For differentiation, genus and species are printed in italics; other ranks—class, order, and family—in roman type.
2. Relationship. A taxonomic discussion treating the problems suggested by the specimens considered.
3. Key. A table, usually arranged dichotomously, for facilitating preliminary determination.

[8] Although this form is maintained in botanical reports, the name of the second author is often omitted in zoölogical treatises. See *International Rules of Zoölogical Nomenclature*, Article 23. *Taenia lata Linné*, 1758 becomes *Dibothriocephalus latus* (Linné, 1758) Lühe, 1899.

4. Description. A catalogue to make identification complete. In addition to its characters, the original description and the authority for each species should be cited.
5. Material. An indication of
   A. The type, with full information regarding sources, dates, and collectors.
   B. The sex
   C. The present location, especially of the specimens designated as types.

III. ILLUSTRATION. A representation, often micrographic, of the individual specimens. In this connection, a useful article is "Standardized Microphotography," by Alexander Petrunkevitch, of Yale University, in the *Anatomical Record* (Pan-American Edition), XIX. 289-307 (October, 1920). The order of the figures may coincide with the references in the text.

Even though prepared by the same author, the three main divisions are usually separated from one another. A typical faunal report, illustrating this separation, is *The Dipterous Genus Dolichopus Latreille in North America*, United States National Museum Bulletin 116 (1921), by M. C. Van Duzee, F. R. Cole, and J. M. Aldrich. This report consists of three distinct parts:

1. Introduction, by Mr. Aldrich
2. Classification, by Mr. Van Duzee
3. Plates, by Mr. Cole

In the "Introduction," Mr. Aldrich points out that "the dipterous family Dolichopodidae offers such a storehouse of material bearing upon the Darwinian theory of sexual selection that its many beautiful and easily classified species ought to be much more widely known." After indicating the purpose of the report, he cites two genera—*Psilopus* and *Dolichopus*—which are rich in species possessing easily distinguished characters. These characters, he adds, may be classified as those which occur only in males and those which occur in both sexes. Then follow references to three species previously described as

well as to two reported for the first time. The rest of the paper deals with the origin of the study, the nature of the collaboration, the source of the material, and the disposition made of it. All these points, which are supplemented by a bibliography, are covered in less than seven pages.

The bulk of the report—296 pages—is devoted to the classification. Following a general analysis, which consists of a series of keys, mostly dichotomous, and which extends to 30 pages, are 119 descriptions similar to that quoted below:

(1)

No. 2. Dolichopus Monticola, New Species

Male.—Length, 4 mm., of wing, 3.5 mm. Face of moderate width, ocher yellow above, becoming white below. Front green, shining. Antennae (Fig. *2a*) [omitted] wholly black; third joint about as long as wide, somewhat orbicular in outline, still pointed at tip, proboscis and palpi black, orbital cilia wholly black.

Thorax green with blue or sometimes bronze reflections, a little dulled with brownish pollen, which is almost invisible when viewed from above; pleurae more black with gray pollen. Abdomen green with slight bronze reflections and narrow black incisures; the white pollen on its sides rather abundant. Hypopygium black, its lamellae of moderate size, somewhat triangular in outline, but rounded apically, whitish with broad black border, fringed with fine brown hairs on apical portion, a little jagged at lower corner.

Coxae, legs, and feet wholly black, the articulations of the femora and tibiae narrowly brownish yellow. Fore coxae covered with white pollen and little black hairs on their anterior surface. Middle and hind femora each with one praepical bristle, the latter not ciliate, but with very minute, delicate brown hairs on lower inner edge. Hind tibiae gradually thickened apically; the glabrous stripe on upper edge may be seen for nearly their whole length as a narrow shining line between the two rows of large bristles. Fore tarsi plain, not longer than their tibiae; the basitarsi nearly as long as the remaining four joints taken together; fourth joint slightly shorter than fifth, which is about as long as the third; middle and hind tarsi each a little longer than their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (Fig. 2) [omitted] dark grayish, strongly tinged with brown in front of third vein, sometimes back to the fifth, except

beyond the cross vein, where it is grayish; cross vein slightly bordered with brown; costa not enlarged at tip of first vein; last section of fourth vein bent just before its middle; hind margin of wing not indented at tip of fifth vein, evenly rounded, the anal angle being nearly obsolete.

Female.—Face broad, about half as wide as long; wings darker than in the male; otherwise about as in the male.

Described from 11 males and 9 females, taken on Mount Constitution, Washington, July 7-17, by J. M. Aldrich; and 1 male taken at Bear Lake, British Columbia, July 20, by R. P. Currie, in the United States National Museum collection.

Type and allotype in the National Museum, from Mount Constitution, Washington.

Type.—Male, Cat. No. 22977, U. S. N. M.

Fully as important as the descriptions are the plates, which contain 217 figures. So valuable are illustrations of this character that in many reports the number of plates accompanying the text is placed beneath the title as a guide to the reader. Although the classification may be altered, the usefulness of the plates, if they are at all accurate, is not likely to be affected. If there has been collaboration, the author of the plates may eventually be regarded as an equal authority with the writer of the text. Indeed, in particularly old monographs, the figures are sometimes the chief reliance. It is always well, therefore, to determine with the utmost care the amount of space to be devoted to each method of interpretation and to assign definitely the responsibility for each section of the report.

Exercise: A Taxonomic Report.—Prepare a taxonomic report upon a single species of fauna or flora in the neighborhood.

Ecological Reports.—The third kind of descriptive report of service to biologists is that which deals with the environment of animals and plants. In it the author is concerned with processes and successions. The unit of description is not the species but the community or "association," as it is called. And the dynamic features of the community or the association are uppermost in the mind of the ecologist. As might be expected, the text differs materially from the text of a taxonomic report. The main divisions, however, are the same.

The function and arrangement of this kind of report can be illustrated effectively by a few quotations from *An Ecological Study of Prairie and Forest Invertebrates,* Illinois State Laboratory of Natural History Bulletin XI, an interesting monograph by Charles C. Adams, Director of the New York State Museum:

The purpose is set forth clearly in the following passage:

(2)

ANIMAL ASSOCIATIONS OF THE PRAIRIE AND THE FOREST

I. INTRODUCTION

In an earlier chapter of this paper the habitats and animals found at the different stations were discussed, and in the preceding section the general characteristics of the physical and vegetational environment of the prairie and forest have been described and summarized. We are now in a better position to consider the relations of the invertebrates not only to their physical environment, but also to the vegetation, and, furthermore, the relations which these animals bear to one another. We wish also to consider both the prairie and the forest as separate units, and to see how the animals are related to their physical and biological environment. As previously stated, the special localities studied were described by stations both to give a precise and concrete idea of the prairie and its animals, as now existing in a limited area, and also to preserve as much of the local color as the data would permit. I wish now to re-examine these animals from another standpoint, that of the animal association as a unit. The prairie as a whole is not homogeneous from this point of view; it is a mosaic composed of a number of minor social communities. Each of these smaller units, however, is fairly homogeneous throughout.

Our present knowledge of these minor associations is imperfect, and for this reason they are arranged in an order approximating that which we might reasonably expect to be produced if the initial stage were made to begin with a poorly or imperfectly drained area and to advance progressively, with corresponding vegetational changes, toward a more perfect condition of drainage. Upon the prairie a perfect series would include every stage from lakes, ponds, and swamps to well-drained dry prairie. But cultivation and drainage have obliterated so much that now only very imperfect remnants exist in the vicinity of Charleston. Although the sequence

followed, therefore, does not include all stages of the process, it is approximately genetic.

There are three essential features in every animal association, or community: certain physical conditions; certain kinds of vegetation, which also modify the physical conditions; and representative kinds of animals. Occasionally an effort is made to divorce these, to separate organisms from their normal habitat, but such an effort is deceptive; for no organism can live for any considerable period without a normal environment.

I have not attempted to treat these associations with equal fullness. In the sections devoted to the description of the stations it was possible in some cases, on account of the uniform character of a station, to describe the animal association rather fully. In such instances the detailed account is not repeated. In other cases I have elaborated the community relations more fully here than elsewhere. The descriptions of the stations and the associations, and the annotated lists, are intended to be mutually supplementary.

The arrangement is indicated by the table of contents:

DESCRIPTION OF THE FORESTS, HABITATS AND ANIMALS

1. The Bates woods, Station IV
2. The upland oak-hickory forest, Station IV,*a*
3. Embarrass valley and ravine slopes, forested by the oak-hickory association, Station IV,*b*
4. Lowland or "second bottom," red oak-elm-sugar maple woodland association, Station IV,*c*
5. Supplementary collections from the Bates woods, Station IV
6. Small temporary stream in the south ravine, Station IV,*d*

GENERAL CHARACTERISTICS OF THE GROSS ENVIRONMENT

1. Topography and soils of the state
2. Climatic conditions
3. Climatic centres of influence
4. Relative humidity and evaporating power of the air
5. Temperature relations in the open and in the forest
6. Soil moisture and its relation to vegetation
7. Ventilation of land habitats
8. The tree trunk as a habitat
9. Prairie and forest vegetation and animal life
10. Sources and rôle of water used by prairie and forest animals

In general, a report of this character contains three main sections:

I. INTRODUCTION

II. DESCRIPTION
   1. Areas Studied
   2. Communities Discovered
   3. Processes Observed

III. SUPPLEMENT
   1. Lists
   2. Bibliographies
   3. Illustrations
      (a) Areas
      (b) Communities

Most of these sections do not require any extended comment. The introduction is usually a brief historical review.

The description of the areas naturally touches all determinative factors such as temperature, humidity, and evaporation. The character of the sections dealing with the communities is shown in the extract below:

3. The Forest Undergrowth Community

Above the soil, in the layer of herbaceous and shrubby vegetation in the Bates woods, lives a considerably different assemblage of animals from that in the soil. Running about over this vegetation, or resting on it, are found the harvest-spiders, and in webs spread between trees and shrubs are found *Epeira insularis* and *verrucosa* and *Acrosoma spinea* and *rugosa*.

In the Cottonwood forest at Urbana, cutting has made rather open spaces so that there is considerable undergrowth, including much spice bush (*Benzoin*); among these bushes two spiders thrive, *Epeira insularis* Hentz and E. *domiciliorum* Hentz. The leaf-footed bug, *Leptoglossus oppositus* Say (Pl. XXII, Fig. 4) also abounded on these plants. *Insularis* is also in the Brownfield woods. The jumping spider *Phidippus audax* Hentz, and *Acrosoma rugosa* were also taken in the Cottonwood forest. In a dense shady flood-plain forest at Muncie, Illinois, *Acrosoma rugosa* and *Epeira verrucosa* and *labyrinthica* were taken August 3. The harvest-spiders *Liobunum* are largely animal scavengers but the true spiders are of course strictly predaceous. The location of the spider-webs, near the ground, attests the flight of insects upon which they depend for food. The numerous snails feed to a large degree upon the herbaceous plants of this lower layer, as do plant-feeding *Hemiptera* and the grass-eating *Lepidoptera*, including the woodland butterflies *Enodia* and *Cissia*, other *Lepidoptera*, and *Everes, Autographa, Polygonia,* and, possibly, the katydid *Amblycorpha*. In the shrub layer *Epeira domiciliorum*, folded among leaves, is a characteristic animal. It seems to thrive best in more open woods than those in which *Acrosoma* abounds. Nettles (*Laportea*) and clearweed (*Pilea*) were not searched for animals, but were undoubtedly inhabited by a number of kinds. The same is true of the shrubs. Young trees in this layer appear less liable to attack by gall-producing insects than larger trees are.

The following insects feed upon woodland shrubs, and were taken at Bloomington: *Cerambycidae*—*Liopus alpha* Say, June 18 (bred from sumac by Felt, '06, p. 482), and taken by me on elm during June; *Liopus fascicularis* Harr. (*xanthoxyli* Shimer),

June, recorded as from prickly ash, *Zanthozylum* (Packard '90, p. 659); and *Molorchus bimaculatus* Say, copulating April 17, reported from dogwood, redbud, twigs of maple and hickory, (l. c., '90, p. 293, 424). The curculiorid *Conotrachelus semiculus* Lec., was taken October 10, 1891, from the inside of a very ripe papaw at Bloomington; another specimen was captured during August at Havana, Ill. Felt ('06, p. 582) records *seniculus* as from hickory and butternut. *Attelabus rhois* Boh. was taken July 4, on hazelnut, at Bloomington. It is recorded from sumac, dogwood, alder and oak.

For lists of *Coccidae* living on woodland (and other) shrubs see Cockerell ('97).

The annotated lists are brief commentaries on the individual specimens:

Scarabaeidae

Geotrupes splendidus Fabr. Splendid Dung-beetle

This dung-beetle was dug from a hole, an inch or so below the surface, in the hard-clay of the pathway near the margin of the forest bordering the cleared area (Sta. IV,*a*), Aug. 22 (No. 120). As cattle and horses were pastured in this forest, its presence is readily accounted for.

Pelidnota punctata Linn. Spotted Grape Beetle.

Only one specimen of this beetle was taken. It was found on a grape leaf (Sta. III,*b*), Aug. 15 (No. 58). This insect is primarily a forest or forest-margin insect. The larva feeds upon the decaying roots and stumps of oak and hickory. The adult devours leaves of the grape and of the Virginia creeper.

Many undetermined scarabaeid larvae were found in a much-decayed stump in the ravine near the small temporary stream (near Sta. IV,*d*), Aug. 22 (No. 130).

The other sections are not likely to cause difficulty. In passing, however, it may be well to emphasize the importance of the illustrations. In Dr. Adams' report, 17 plates refer to the areas and 46 to the communities. This proportion is fairly characteristic.

Exercise: An Ecological Report.—Prepare an ecological report on a small area in the neighborhood such as a woodlot or a meadow. Include only the more obvious features covered by the outline above. If possible, add photographs as well as drawings.

Biometrical Reports.—The last of the four groups of reports mentioned is that in which the descriptive methods of the "exact" sciences are applied to the biological sciences. In reports of this kind, which deal with such divergent subjects as the expectancy of death in man and the anatomy of the smallest insect, correlations and variations are indicated by numerical values. In them, therefore, biological conceptions are expressed in terms of mathematics. These statistical studies are quantitative descriptions as opposed to the individual descriptions of the taxonomist and the communal descriptions of the ecologist. Since the language of such reports is that of mathematics instead of morphology, the text differs widely from that of all other descriptive reports employed by biologists.

Their distinguishing characteristics can be illustrated by a specific example. "A Second Study of the Variation and Correlation of the Human Skull with Special Reference to the Naqada Crania" (*Biometrica,* August, 1902, I: 408-467), a monograph by Cicely D. Fawcett, Alice Lee, and other biometrists, in University College, London, consists of twelve parts headed respectively:

1. Introductory and Historical
2. The Material
3. Brief account of the Naqada Race
4. Measurements made and Methods of Measurements
5. The Determination of Capacity
6. On the Degree of Homogeneity Possessed by the Naqada Crania
7. Mean values of the Cranial Characters of the Naqada Race and their comparison with those of Allied and Other Races
8. General Points as to Results and Methods of Measuring
9. On the Numerical, Analytical, and Graphical Representation of Variability in the Naqada Race
10. On the Correlation of the Cranial Characters
11. Summary of Conclusions
12. Appendix of Naqada Cranial Measurements

A glance at these headings will suggest the four main elements of every biometrical report; the introduction, the method

of measurement, the measurements, and the relations which they indicate. Even more suggestive are the tables which deal with the facts established by an examination of the 400 skulls collected by Professor Flinders Petrie. These tables, which are devoted to such topics as circumference and capacity, are the essence of the report.

Some consideration of statistics is therefore necessary. Although the subject has been discussed briefly in connection with administrative reports (Chapter 7), the discussion is hardly applicable here because only the simpler methods are employed in such reports. In the preparation of biometrical reports, on the other hand, the most advanced methods are often used. A student cannot handle biological material satisfactorily unless he is familiar with the theories of probability and chance, with correlation, with curve fitting, with the analysis of time series, etc. Although an exposition of these topics would be out of place in this chapter, a reference to a few of the most helpful books and papers may be of assistance. One of the most satisfactory books, already cited, is *Introduction to Medical Biometry and Statistics* (Philadelphia, 1923), by Raymond Pearl. Other recent books in the field are: Arne Fisher's *The Mathematical Theory of Probabilities* (2nd ed., New York, 1926), G. C. Whipple's *Vital Statistics* (2nd ed., New York, 1923), and G. Udny Yule's *Introduction to the Theory of Statistics* (8th ed., London, 1927). The last two books contain bibliographies which cover the major works in the field up to the time of their publication. Of the papers which should be consulted, those by Professor Karl Pearson and his associates are of the greatest value. With these books as a starting point, and with papers like those by Professor Pearson for mileposts, a student should have no difficulty in mastering the technique of biometrical reports if he is willing to work. He must work, however, for the methods employed are not simple.

Another point, perhaps, should be emphasized. For convenience of reference, biometrical reports have been considered here as descriptive reports. Biometrical methods, however, are used extensively in experimental biology. Although some biometrical reports, like the report cited in illustration, are typically

descriptive, others reflect the characteristics of descriptive reports and experimental reports as well. Others, again, are distinctly experimental reports.

Exercise: A Biometric Report.—Prepare a biometric report on the variation of some one character in a species which you have under investigation.

Reports in the Physical Sciences.—In the physical sciences, the descriptive report is much less significant than in the biological sciences. Nevertheless, it is employed with three distinct kinds of subjects. How it is adapted to the treatment of substances, mechanisms, and formations will be explained in the next sections.

Reports on Substances.—Although it is true that much of the classification required by the physical sciences has been done, the opening of new fields constantly leads to reports on substances which have just been discovered. Many researches in physiological and synthetic chemistry have led to such results. In aim, these reports, dealing, for example, with nucleins and enzymes, are similar to the taxonomic reports of the biologist. So far as the main divisions are concerned, the arrangement is the same.

Reports on Mechanisms.—Although subjects such as nucleins and enzymes are naturally treated only by distinguished scientists, there is another kind of subject which is treated even by students. Mechanisms and machines which are known in one country and one laboratory but which are not known in another country or another laboratory represented by the writer may be described by him as a contribution to knowledge. A characteristic report of this nature is "Power Equipment for Aircraft Radio Transmitters," *Proceedings* of the Institute of Radio Engineers XIX: 59-77 (1931), by J. D. Miner. In it the advantages and disadvantages of each of six types of power equipment are considered. Of somewhat different scope is the study by Smith J. DeFrance, *The N.A.C.A. Full-Scale Wind Tunnel,* National Advisory Committee for Aeronautics Report 459 (1933), which contains a complete description of the full-

scale wind tunnel at Langley Field, Virginia, and the apparatus for measuring the forces acting on a full-sized plane at speeds varying from 25 to 118 miles an hour. In a science like aeronautics, which is still in its infancy, such reports, consisting of introduction, description, and illustration, tend to promote knowledge and to stimulate invention.

Exercise: A Report on a Mechanism.—Prepare a descriptive report containing the three elements mentioned in the last sentence on a piece of apparatus in a laboratory to which you have access.

Geological and Mineralogical Reports.—The third group of subjects treated in the descriptive report is the most important. This group, which includes geology and mineralogy, has developed its own forms. The geological report, which is essentially academic in character, serves as a basis for the more distinctly practical mineralogical report. In arrangement, however, the two do not differ greatly; and the excellent *Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey,* furnishes an exposition of the technique of preparation which is recognized as standard.[4]

An outline follows:

INTRODUCTION
  Location and area of the region
  Outline of the geography and the geology

TOPOGRAHY
  Relief
  Drainage

DESCRIPTIVE GEOLOGY
  Stratigraphy
    Sedimentary rocks
    Igneous rocks
    Metamorphic rocks
  Structure

[4] Every writer of technical reports should own this valuable guide-book on style and form in technical writing. It may be purchased from the Superintendent of Documents, Government Printing Office, Washington, for fifteen cents. The fourth edition, revised and enlarged by Bernard H. Lane, Editor, 1925—, appeared in 1935. This latest revision no longer contains the material reprinted here but substitutes a section, "Reports on Mining Districts," by G. F. Loughlin, which should be consulted by those working in the field.

GEOLOGIC HISTORY
Sedimentary record
Igneous record
Geomorphic record
MINERAL RESOURCES
INDEX

(3)

GENERAL SUGGESTIONS

It is neither desirable nor possible to make all folio texts conform strictly to a single type, but the point of view, the scope, and the general arrangement should be fairly uniform.

POINT OF VIEW.—The author should have constantly in mind the primary object of the folio, which is the presentation of a clear picture of the region described. He should therefore endeavor to put himself in the mental attitude of a person—preferably not a trained geologist—who has never seen the region and who must form his conceptions of it chiefly from the written report. Too much dependence should not be placed on the cartographic picture, for most laymen do not read maps with facility.

SCOPE.—Although the folios are intended for both laymen and geologists, the descriptive text should not trespass on the subject matter of a geologic textbook. The folio-cover text includes most of the definitions that are necessary. For the layman it will ordinarily be better to explain the technical ideas involved in the local descriptions than to define technical terms, but in some folios the need for repeated use of the idea will be best met by first defining and afterward using the corresponding technical term. It is manifestly impossible to make provision for any but the educated layman, and some material may be admitted which even he will not readily understand, provided the text as a whole is fairly intelligible to him. Those technicalities of the specialists which are not understood by the body of geologists or by specialists in other departments should generally be avoided. Important matters of particular interest to the specialist may be concisely stated without descriptive details.

The text should be devoted mainly to the discussion of facts of permanent interest. For example, in the discussion of mineral resources, mode of occurrence should receive fuller treatment than amount of exploitation. Also, more attention should be given to

the description of the phenomena of the area than to theories of origin and history of development. Such theories should be stated tersely and clearly and not in controversial or argumentative form. If a theory is not generally accepted or is supported mainly by phenomena outside of the area discussed, whatever doubt may exist as to its validity should be mentioned.

ARRANGEMENT.—The material should be arranged under a few main heads; five or six will generally suffice, though more may be used if exceptional importance of special features make their coordinate treatment necessary. A table of contents that is applicable to many geologic folios is given at the head of this section.

INTRODUCTION

The introduction should include a brief statement of the location of the quadrangle in respect to latitude and longitude and to State and county boundaries. The area should be stated exactly, to the nearest whole number of square miles, which can be ascertained by reference to "Geographic Tables and Formulas," published by the Survey as Bulletin 650 and also as an unnumbered pamphlet.

The folio should include a brief description of the main geographic and geologic features of the natural province of which the quadrangle forms a part. This description may be repeated with little change in a folio on another quadrangle in the same province. As it is intended chiefly to supply the layman with the necessary background for the detailed discussion to follow, it should be written in language as free as possible from technical expressions. The exact relations of the quadrangle to the natural province should be clearly stated.

TOPOGRAPHY

The description of the topography should be general, principal purposes being (a) to furnish a local nomenclature to be used in the descriptive geology and (b) to direct attention to the main features represented on the topographic map and thus assist the untrained map reader.

The origin of the topographic forms can be most advantageously discussed after the stratigraphy and the structure have been described. Its discussion naturally forms a part of the geologic history. The fact that topographic relief is discussed in this section and physiography in a later one need not prevent the consideration of the topographic expression of rock formations as a part of the description of them.

Descriptive Geology

Stratigraphy.—The description of the sedimentary formations should generally be systematic, though it may differ in detail for different regions. If the formation units have been long established and are well known, the description may be relatively brief. The definition should include (a) lithologic character and name; (b) topographic expression, provided that is characteristic; (a) paleontologic character; (f) geologic correlation; (g) relation to adjacent formations, especially character of upper and lower limits, whether by gradual passage or unconformity. These items need not invariably be presented in the order indicated above; peculiar conditions may justify their discussion in a different order.

Under the heading "Paleontologic Character," at least three conditions may require somewhat different treatment. (1) If the fauna or the flora is well known, it will be sufficient to give, in a brief paragraph, a broad classification of the fossils, with mention of a few species that may be useful in identifying the formation. (2) If the fossils are of doubtful significance or if the life of the epoch is not well known, a somewhat more explicit statement is desirable. (3) If the fauna or the flora is very scant or poorly known, or if the investigation has added valuable new material, a still more detailed reference to specific forms may be made, especially if the assigned age has been determined on this newly discovered evidence or if divisions are based on paleontologic difference. If the geologist is not also a paleontologist, he should procure a concise statement from the paleontologist and quote it.

The igneous rocks should be described primarily to explain the cartographic units adopted. A generalized pen picture of the rock, giving its obvious features, should be followed by a more technical description showing which features are general and due to the type of the magmas erupted and which represent local conditions of consolidation. A concise designation or description for the petrographic specialist is desirable, but as a rule no extended description or discussion of details, such as would interest the specialist only, should be given. If petrographic details are considered essential, they may be printed in paragraphs set in smaller type, which can be skipped by the non-technical reader. In general those features of the rock that have a bearing on and are essential to a discussion of the geology of the region should be described. Chemical analyses should be given, if available, with brief comment as to their significance but without detailed or technical discussion.

The method of treatment of metamorphic formations should depend on the relative prominence of their original and their acquired characteristics. If the original characteristics are the more pronounced the treatment should be similar to that of sedimentary formations; if the acquired characteristics are the more pronounced, the treatment should be the same as that of igneous rocks.

STRUCTURE.—The description of the geologic structure should be clear, concise, and as free as possible from technicalities and from theoretical discussion of the causes producing it. The importance of this subject differs greatly in different regions, and its treatment should be determined by its importance. In some regions the structural features, though inconspicuous, are highly important by reason of their influence on the accumulation or exploitation of mineral deposits, such as oil, gas, and coal. The discussion of such features should be sufficiently full and explicit to form a groundwork for the subsequent discussion of the mineral resources. The relation between structure and mineral deposits should be pointed out in connection with descriptions of those deposits.

Geologic History

The discussion of the geological history should present a chronologic record of the area. The subdivision into "sedimentary record," "igneous record," and "physiographic record," is suggested as desirable where applicable, but in many folios the sedimentary and igneous history will necessarily be combined in a chronologic account of events. The "physiographic record" should include a discussion of the origin of the present topographic forms.

Mineral Resources

In general the detail devoted to economic geology should be roughly proportional to the value or quantity of the resources and the need of information. Particular care should be taken to record such general facts in regard to the mineral resources as will enable the reader to make an intelligent estimate of the value of both the developed and the undeveloped deposits. If the mineral resources are extensive and if a large amount of detailed information that is of economic value has been collected, the material should be prepared for publication as a bulletin, and the discussion of the economic geology in the folio text should be confined largely to a statement of the purely geologic relations of the mineral deposits.

More attention should be devoted to water resources in a folio that describes an agricultural or ranching country than in one that

describes an area where mining is the dominant industry, or in a folio on an arid or semiarid region than in one on a region which is well watered and in which the problems of water supply are well understood. The discussion of the underground water supply should include (a) an enumeration of the water-bearing formations or beds and descriptions of their character supplementary to those given under "Descriptive Geology"; (b) a description of the geologic structure of the water-bearing beds, with statements of depth and of elevation of outcrop; (c) a statement as to the quantity and character of water.

So far as the geological report is paleontologic—that is, so far as it deals with the fossils of a period—it is dependent upon the technique of the faunal and floral report. This dependence should emphasize the fact, already stressed, that the types treated in this volume are far from rigid. They constantly coalesce, one merging into another, in response to new conditions and new developments. Only a writer who regards them as fluid and tentative is likely to realize their infinite possibilities.

Exercise: A Geological Report.—Prepare a geological report upon a limited area in the neighborhood.

CHAPTER 22

PREPARATION OF MANUSCRIPT AND REVISION OF PROOF

Procedure in This Chapter.—After a report has been drafted, a writer is confronted with the necessity of submitting it to his employers, clients, or colleagues in typed or printed form. As a rule, administrative and professional reports are first presented in manuscript even though they are afterward printed for distribution among the stockholders of a company or the members of a committee. Independent reports, on the other hand, invariably appear as articles or monographs. Consequently, two distinct problems must be considered. These problems can be approached most effectively from the standpoint of professional and independent reports. This chapter is therefore devoted to the routine followed in the preparation of (1) a professional report for a client and (2) an independent report addressed to the public. Whether it is typed or printed, the routine adopted in the preparation of an administrative report is exactly the same as in the other two cases.

Manuscript for a Client.—The material required in the preparation of a professional report includes bond and carbon paper.

Today reports are filed exactly like letters. Except for special sheets 11 x 13 used for folded tables, the paper employed for both ribbon and carbon copies should therefore be of ordinary letter size, 8½ x 11. Since a manuscript must not be hard to read, must not be cumbersome, and must not go to pieces when it is handled, the paper should be white, light, and tough. To keep the typing clear and uniform, the copying ribbon, which should be black, ought to be renewed from time to time. If it is not renewed promptly, the ink will fade in spots and produce a variegated effect.

The carbon paper, which should be black, ought to be replaced after ten impressions have been taken from it. Except in the case of pages devoted to tables, at least four duplicates should be made. Two of these duplicates should be furnished to the client with the original manuscript, and two should be retained. Some engineering firms place one of the duplicates in the office file and one in the office bookcase. Five duplicates of pages containing tables should be made. One of these is to take the place of the ribbon copy, which should not be included in the manuscript but which should be endorsed on the margin at the left and reserved for reproduction.

Appearance of the Text.—The appearance of the text depends upon the arrangement of the pages, margins, headings, spaces, and tables.

Because a long report prepared in an office is usually divided among several stenographers, and because inserts are often necessary, it is sometimes impossible to arrange the pages as they are typed. For this reason, the sheets in each group should be numbered consecutively in the upper left-hand corner and renumbered in the upper right-hand corner after they have been completed and collated. An interpolation may be indicated by placing small letters after the figure referring to the preceding page, as 10a, 10b, etc.; an elision, by attaching the number of the last sheet removed to that of the last sheet left, as 64-70, 88-90, etc.

Since a report is usually bound on the left, margins at that edge should not be less than 2 inches. At the top, they may be 1½ inches. These figures, however, represent the minimum. There should always be sufficient space for editing.

When center heads are employed to indicate the main divisions of the report, the titles should be written in capitals but not underlined. When sideheads are used to indicate the subdivisions, the titles should be written in lower case letters, the principal words only being capitalized. The whole titles, which are indented in the usual manner, should then be underscored.

That part of the text which is original should be double-spaced. Quotations extending over more than a couple of lines should be single-spaced, and the margin on the left should then

be widened. So far as possible, the same number of words should be placed on each page. The usual number is 250.

Although the important words in the titles of tables are always capitalized, they should not be underscored. It is a good plan, also, to draw lines around tables; in other words, to "frame" them. If this procedure is impracticable, horizontal lines should be drawn above and below the column headings. Tables should be numbered by arabic figures, as Table 20, etc. The numbers of columns should be placed in brackets; as [5], etc. If there are only two columns in a table, perpendicular lines are unnecessary. If they are needed, they can be drawn by hand after the typing is finished. To permit an even division of the titles as well as of the columns, the column headings should be correlated with the corresponding figures.

Maps, Plans, Charts, and Sketches.—As explained in Chapter 7, the graphic elements of a report consist of two distinct groups: maps and plans, and charts and sketches. Maps and plans, submitted independently as exhibits, ought to be 24 x 36 or 24 x 18. Charts and sketches, which appear in the text or the appendix, ought to be of the same dimensions as the manuscript; that is, 8½ x 11. Since the new processes of photographic and photostatic reproduction make it relatively easy to reduce or enlarge any drawing or illustration to the standard size, it is seldom necessary to use large illustrations. If maps which cannot show the proper detail in an 8½ x 11 size are employed, it is well to fold them in such a way that they will open readily to the right and to keep the height at the standard 11 inches.

Photographs now often form an interesting addition to typed reports. As a rule they appear adjacent to the references to them in the text. Special care should be taken to design the pages which carry illustrations so that the flow of the text will be uninterrupted. If a single photograph is to be used on a page, it should be attached flush with the right-hand margin. If more than one appears, taste will dictate the relative positions in relation to the general layout. Certain precautions, however, should be observed. A photograph should never be placed in the middle of the page with the text on both sides.

Nor should a small photograph be left with a disproportionate amount of white space on either side. As a rule photographs should be mounted singly. In attaching photographs to the manuscript page, it is advisable to use art corners or a cement with a base of rubber. Neither method is likely to shrink or curl the paper.

Appearance of the Illustrations.—The appearance of the illustrations will be affected materially by the character of the margins, lines, titles, and letters.

On maps and plans of the ordinary sizes, 24 x 36 and 24 x 18, adequate margins should be left on all sides. On charts and sketches, the margins should be the same as those of the manuscript.

Since practically all illustrations are blueprinted or photostated, the ink used should be black enough and heavy enough to produce clear, bold lines.

The titles of maps and plans, described at length on pages 416-417, should be placed within the border at lower left-hand corner. The titles of charts and sketches are usually placed below the border. In both cases, titles should correspond in size and proportion with the illustrations to which they refer.

As a rule, lettering should be of the single-stroke, vertical type described in standard texts upon the subject. The lines should be numbered in both directions according to a definite system and should be explained by legends reading up and across from the lower left-hand corner.

Filing System.—In a consulting office, each map, plan, chart, and sketch is given a combined accession and filing number as soon as it is completed.

In the main office of Metcalf and Eddy, Consulting Engineers, of Boston, Massachusetts, for example, the reference number for a map or plan consists of three parts: an accession number, a letter indicating the subdivision to which the plan belongs, and a filing number in that subdivision; thus, 1409-C-356. The combined numbers are placed in a circle ¾ inch in diameter, with its center ¾ inch from the lower right-hand corner, and again, for use when the map or plan is inverted, in

a similar circle at the upper right-hand corner. The accession number is entered in the upper zone, with the letter in the middle, and the filing number in the lower zone. When the map or plan is made at the Chicago office of the firm, for example, a line is drawn ¼ inch above each circle. On this line is printed the local accession number; as Chicago-121. The circles, however, are left blank until the necessary data are obtained by correspondence with the Boston office.

In this office, each chart or sketch is numbered in the lower right-hand corner outside the border. The letter is Z, and the combination number is written continuously; as 2000-Z-47.

Every map, plan, chart, or sketch should be properly identified. Within the border at the lower left-hand corner, it is therefore customary to print the following legend:

DRAWN BY.....................
TRACED BY.....................
CHECKED BY ....

If the map, plan, chart, or sketch is too small to carry a legend of this kind, the draftsman's initials in an inconspicuous place, preferably the lower left-hand corner, may be sufficient identification.

Modern Methods of Reproduction.—Because of recent developments, it is now possible to reproduce reports economically and effectively from typescript by means of one of the offset processes which have become available. When such a procedure is adopted, care should be taken to see that the copy is verbally correct and accurately spaced and that the tables, sketches, and photographs are inserted in the text exactly as they are to appear. Manuscript which has been prepared with due attention to such details can be presented in an attractive format, as many of the reports of the Policyholders Bureau of the Metropolitan Life Insurance Company and the Port of New York Authority indicate.

Responsibility for Publication.—Although practically all administrative and professional reports are first submitted privately in manuscript to employers or clients, some are afterwards printed for public distribution. As pointed out at the be-

ginning of this chapter, independent reports are also issued as pamphlets or treatises. Rarely are they of any commercial value. As a rule, therefore, it is useless to seek a publisher to handle them. Although research reports are to be found in the pages of specialized periodicals and the transactions of technical societies, and though their authors are sometimes granted a small honorarium or given a limited number of reprints, they are hardly an exception. Like all other reports, they are of no interest to the "trade." Once they are accepted, the author, who is not likely to go astray in his choice of a periodical or a bulletin, is usually relieved of further responsibility. Ordinarily, however, whether his employer or his client bears the expense, or whether, if he is writing independently, he is forced to bear it himself, he is responsible for the details of publication. The manuscript should therefore be arranged so that the printer who is consulted can easily decide on the form and estimate the cost.

Manuscript for the Printer.—As prepared for the printer the manuscript of an independent report differs little from that of a professional report submitted in typed form. The only topics which require special consideration are quotations, footnotes, and headings.

As suggested earlier in this chapter, the quotations in a report which is to be submitted to a client in typed form are differentiated by indention and single-spacing from the passages which precede and which follow them. This practice is now standard for submitting copy to most printers. If the author is to edit the copy, he may draw a line parallel to the left margin from the beginning to the end of the quoted matter and indicate beside it the size of type which he prefers. It will usually be 2 points smaller than that used in the main body of the text. It is no longer necessary to run off the quoted passages separately.

When a report is submitted in typed form, the footnotes are placed at the bottom of the page. When it is to be published, they are placed in the manuscript immediately after the passages to which they refer and are separated from them by horizontal lines. In the work of the federal bureaus, all footnotes are

placed on separate sheets at the end of the manuscript in order that they may be run off together on a machine reserved for small type. Many technical magazines demand that footnotes be arranged in the same way. Except in large printing plants, however, the other arrangement is ordinarily preferred.

The process of differentiation may be carried even further; and the degrees of emphasis which a writer desires to stress by means of typographical variations in the headings may be made clear by certain mechanical devices.

> LARGE CAPITALS are indicated by three lines under the words to be capitalized; SMALL CAPITALS, used in legends, by two lines. *Italics* are indicated by a straight line, and **black-face type**, employed in center and side heads, by a wavy line.

The ribbon copy should always be made available for the printer, a carbon copy being retained for reference. If it is necessary to ship the manuscript, it should be forwarded by express after a valuation has been placed upon it. The sheets should not be folded.

Illustrations in the Manuscript.—In preparing the illustrations for the manuscript, there are several points which must be considered. Size, arrangement, paper, and workmanship are all important.

Whenever possible, charts and sketches, which, with maps and plans, may be reproduced by zinc or copper etching as described on page 542, ought to be drawn so that they will coincide, when printed, with the type page, 4 x 7, of the smaller size of report. Maps and plans ought to be made so that one dimension will be 7 inches. By this arrangement, they will not need to be folded, ordinarily, more than once. Illustrations which are borrowed from books and articles, and which may be cut out and pasted on separate sheets of paper or left loose with only their corners through slits, can be reproduced without material reduction. Original drawings should be made two or three times the size required for the text.

Except for photographs, illustrations appearing on the smaller sheets should be arranged in order, as Fig. 1, Fig. 2,

etc., arabic numerals only being employed. Photographs, which are usually inserts, and maps and plans which are folded should be classified as plates and numbered consecutively in roman numerals as Plate I, Plate II, etc.

The paper chosen should vary with the kind of reproduction desired. For etching, blue-white bristol is admirable. For half-tone, explained on page 542, a high finish is necessary. If the drawings and photographs are unmounted, numbers and letters may be written in pencil on the back. If they are mounted, fly-leaves may be pasted near the top and folded over the front. In every case, the mounting should be done by an expert.

In the preparation of illustrations to be reproduced by etching the methods include line, stipple, and scratch work. With line work, the number of cross-sections ought to be limited. The lines themselves ought to be fine enough to accentuate the curves and diagrams, but they ought not to be so fine as to lose their identity.

Estimate of Cost.—In addition to the considerations mentioned above, an estimate of the cost by the printer consulted depends upon definite specifications regarding size of type, length of line or "measure," size of page, character of paper, and manner of printing illustrations.

The size of type is indicated by the number of "points," each 1/72 inch, in the base supporting the face used in printing. The approximate measurements in lines to the inch are given below:

KINDS OF TYPE	LINES TO INCH
5 Point	14 Lines
6 Point	12 "
7 Point	10 "
8 Point	9 "
9 Point	8 "
10 Point	7 "
11 Point	6½ "
12 Point	6 "

Ordinarily 10-point type is used for reports. In the manuals of style issued by the government bureaus and university

presses are tables showing the number of words to the square inch. These tables are helpful in forming an estimate of the cost.

The estimate is dependent also upon the length of line. With the advice of the printer, the author must fix the "measure" to be adopted. It is determined largely by the size of page selected.

In general, reports are printed in one of two sizes. Bulletins and pamphlets issued by bureaus, departments, societies, and universities are usually 23 x 15½ centimeters. Practically all research reports as well as most information and progress reports are issued in this form. Examination and recommendation reports containing many figures and plates are often 31 x 23½ centimeters.

Although these facts are important in estimating the cost, the character of the paper selected is more decisive. In reports, it depends largely upon the nature of the illustrations. If they are photographs, a rough stock, which will take only line drawings, cannot be used. Under such circumstances, a fine finish is necessary. Since it may add materially to the expense, illustrations requiring its use ought to be avoided unless they can be arranged as inserts. For very short reports, however, it may cost less to use a glazed stock than to use inserts which must be printed separately and bound by hand.

After these points have been settled, and the kind of binding, to be mentioned later, has been determined, a printer can quote a definite figure. If this is satisfactory, he can proceed at once with the "composition," that is, with the "setting" of the type for the text and also with the manufacture of the plates for the illustrations.

Method of Composition.—Although a report may be "set" by hand if the text is much broken, practically all commercial composition is now done on a monotype or linotype machine. When the first of these machines is used, each type is "cast" separately. When the second is employed, each line forms a unit. Although it seems as if the linotype process might be cheaper than the other, the fact that it is impossible to make even slight alterations without recasting whole paragraphs

makes it, in the end, more expensive. If accuracy is required, it should not be employed.

As the type is cast, it is set, either "leaded" or "solid" in trays about 2 feet long known as "galleys." A "lead" is a thin piece of metal about two points thick which is inserted between lines. If the type is set "leaded," this piece of metal joins it. Consequently, the spacing cannot be altered afterward.

Galley Proofs.—After a number of galleys have been completed, a set of "galley proofs"—that is, long sheets of paper containing impressions made by hand—are forwarded to the writer along with the manuscript. Though glaring mistakes may be corrected by the printer, responsibility for correctness rests upon the author. In the margin of the proofs, it is customary to indicate, by means of certain conventional symbols, the changes necessary. If words are deleted, others occupying the same number of "spaces" should be substituted if it is at all possible. At any rate, alterations should not affect the lines immediately before or after those actually revised. Otherwise whole paragraphs may have to be "run over." So costly are changes of this kind that publishers are accustomed to limit definitely the number which an author may make at their expense. It is most important, therefore, that revision should be strictly localized. Changes in the tables are more costly than changes in the text, especially if they contain vertical rules.

Specifications regarding the make-up of the pages should be noted on the galleys or on sheets of paper fastened to them. These specifications may cover such matters as the length of pages; the style of running heads; the style and position of folios; the position of illustrations and tables; the spacing of heads and tables; and the beginning of new pages. Since ruled tables may have to be transferred if they interfere with the paging of the text, alternate arrangements should be indicated wherever possible. If tables and illustrations are to be placed on opposite pages, facing one another, directions to this effect should be added. Finally, the proofs of the cuts, with the proper captions, should be attached to the galley proofs.

If a report contains many illustrations or tables, it may be advisable for the author to make a "dummy" in order to show

the character of the make-up. In a dummy, the galley proofs, which are cut as needed, and the proofs of the illustrations are combined in proper page lengths. To save labor, the pagination may be indicated on the galley proofs without cutting them.

After the corrections have been made, the positions of the cuts indicated, and the instructions for the make-up given, the manuscript and the proofs should both be returned to the printer. If the author wishes to see that his directions have been carried out, he may ask for another set of galley proofs, called "revised galley proofs."

Page Proofs.—After the galleys have been arranged in pages, "page proofs," accompanied by the revised galley proofs, will be submitted to the author for approval. In examining the page proofs, which will contain the illustrations, the writer should assure himself that

1. Errors are entirely eliminated.
2. Figures are properly placed.
3. Pages are numbered consecutively.
4. Lines are arranged continuously and none are omitted.
5. Material has been broken logically and according to proper rules of make-up.

The author should also adjust any "long" or "short" pages which the printer has been unable to avoid. If he is assured on these points, he may mark the page proofs "O. K.," or "O. K. with alterations," and return them with the galley proofs.

With the page proofs should be forwarded the index, which cannot be made until they have been received. A proof of the index also will be returned to the author for correction. In addition, he may wish to see a dummy of the whole report, with the inserts properly placed, before the printing is begun.

Symbols in the Correction of Proof. The symbols on page 541 are used in the correction of proof. For convenience, they are classified in a number of obvious categories.

Methods of Reproduction.—The figures and plates are usually made by a lithographer or an engraver outside the printing establishment and may be easily mislaid.

1. **Marks Used to Indicate Elision**

Take out ~~this~~ word and close up.

Take out this le~~t~~tter and close up.

2. **Marks Used to Indicate Retention**

stet Let ~~this passage~~ stand as it is.

^ see copy Insert the passage which omitted.

3. **Marks Used to Indicate Changes in the Position of Spaces**

Insert a spacehere.

Arrange the spaces evenly.

Push down the space which has worked up.

ld Widen the space between lines.

4. **Marks Used to Indicate Changes in the Form of Type**

caps Put this passage in capitals.

s.c. Put this passage in small capitals.

rom. Put this passage in *roman* type.

ital. Put this passage in italics.

bf Put this passage in bold face type.

l.c. Put this passage in LOWER CASE.

5. **Marks Used to Indicate Changes in the Form of Letters**

These letters are broken. Substitute.

wf These letters belong to the wrong font. Substitute.

6. **Marks Used to Indicate Changes in the Position of Letters**

tr Transpose these lettres and words these.

Reverse these letters.

7. **Marks Used to Indicate Changes in the Alignment of Letters**

Straighten crooked letters in the line.

Straighten letters beside the margin.

Raise letters appearing below the line.

Lower letters appearing above the line.

8. **Marks Used to Indicate Changes in the Position of Words**

run over Carry over to the next line.

run up Run up to above line.

center Put in the middle of the line.

9. **Marks Used to Indicate Changes in the Position of Paragraphs**

¶ Start a new paragraph here.

no ¶ Do not start a new paragraph here.

10. **Marks Used to Indicate Changes in the Position of Lines**

Indent one space.

Move to the left.

Move to right.

11. **Marks Used to Indicate Changes in Punctuation**

There should be a period here

If this is correct there should be a comma here.

= There should be a hyphen in gutta percha.

There should be quotation marks before and after

The Safe

Insert an apostrophe in companys.

Two methods of reproduction—manual and mechanical—are now employed. Since the first method is limited, as a rule, to the preparation of hand-colored plates for expensive faunal and floral reports, the mechanical processes alone require detailed explanation. Though there are three of these processes—planographic, relief, and intaglio—only the first two are of general interest.

Of the planographic processes—that is, of those in which the printing is done from a plane surface—lithography alone is of notable importance, and even lithography has given way largely to other processes. Today it is practically never employed in the physical sciences. It is employed, however, in the biological sciences in black-and-white and, especially, in color work.

Relief processes, which are employed in both the physical and the biological sciences, include wax-engraving, zinc and copper etching, photogravure, half-tone, and the three-color process. The first four are limited to black-and-white.

Wax-engraving, used for the reproduction of maps, is also used at times for the reproduction of charts and sketches. Today, however, the cost is practically prohibitive.

Etching, either on zinc or copper, is well adapted to the reproduction of charts and sketches in which there is little detail. In this process, which is general, the illustrations are photographed on sensitized plates that are afterward etched by acid for printing.

Theoretically, photogravure, by which drawings and also photographs can be reproduced with remarkable accuracy, should be the most useful of the processes mentioned. Actually, because of its cost, it is of slight importance.

Half-tone is of much greater value. By this method, which is really an extension of the process employed in zinc and copper etching, the images are disintegrated into numerous series of dots reflecting the lights and shadows of the originals. In practice, half-tone is widely used where zinc and copper etching is not adapted to the character of the reproduction desired.

The three-color process, in which the printing is done with red, yellow, and blue inks, is universally employed where repro-

duction of color is necessary. It gives excellent results, and its cost is not excessive.

It should be noted that the expense of reproduction by even the cheapest methods is now one of the largest items in publication. For this reason, the number of illustrations ought to be kept at the minimum consistent with effective exposition.

Printing and Binding.—Although "plates"—stereotypes and electrotypes—are used in printing books of permanent value for which there is likely to be continuous demand, reports, which are usually of immediate interest only, are almost invariably printed from type. The cost of preparing plates is seldom justified. To keep down the expense, a cheap paper cover, generally grey in color, is often employed with the smaller size of page. With the larger, a dark cloth binding, unlikely to fade, is more common. The short title and the year of publication, occasionally supplemented by other data, are ordinarily stamped on the back.

Copyright.—As previously indicated, few reports are of any commercial value. It is seldom necessary, therefore, to take out a copyright for financial reasons. In practice, only research reports dealing with methods of construction or operation are commonly protected. Not more than five per cent of the printed reports examined in the preparation of this volume were copyrighted. Indeed, since the aim of most writers is to popularize certain facts, a check upon quotation is seldom advisable. On the other hand, a writer may wish to control the use of his material. Under these circumstances, reservations based on legal sanctions are undoubtedly justifiable.

If it is considered wise to limit the use of material published in the United States, application for copyright should be made to the Registrar of the Copyright Office of the Library of Congress on one of the blanks provided for the purpose. The essential facts are the date of application, the name and address of the applicant, the name of the author, the title of the report, the number of volumes, the date of publication and distribution, and the name and address of the person to whom the certificate of copyright is to be sent. These facts must be

supplemented by an affidavit to the effect that type-setting, binding, and printing have been done in the United States; by a fee of one dollar; and by two copies of the report. If the report is not to be offered for sale, the fee and the two copies are not required. Whether it is offered for sale or not, a statement of copyright, with the date and the name of the owner, must appear in a prominent place. It is usually printed on the back of the title page. If these precautions are taken, a report registered at Washington is not likely to be used improperly. If it is published in Canada, the procedure is practically the same.

APPENDIX

RECENT COMMENTS ON REPORT WRITING

As the copy for this book was going through the press, the authors received a number of enlightening comments from executives who have shown great interest in the subject of report writing. Several of them, which seemed so significant as to deserve publication, are reproduced below, by permission of the writers.

1. From a letter to the authors, November 17, 1937, by Major John Coffee Hays, Vice-President, Stone and Webster Engineering Corporation:

. . . I would like to make some general statements which I think are particularly important in connection with reports. . . .

I think . . . I explained to you that my experience has made me of the opinion that the most important thing in report writing is a clear cut definition of the scope and constant vigilance to guard against any statements which are susceptible of being interpreted in a way which would be misleading. This, of course, applies particularly to so-called "opinion reports." The client who really wishes an opinion would like to have a simple "yes" or "no," and I think you can readily understand that this is the hardest type of report to write because it requires a very complete knowledge of the subject and must take into account all contributing factors. In our work we are willing to give anything from a mere impression to an unqualified opinion and ranging between an isolated or relatively unimportant feature of a company's business up to a comprehensive review of the entire business of the company. All of this is with the understanding, however, that the basis of our study be clearly understood.

As an extreme illustration: we are willing to say what we think of a manufacturing plant after simply walking through the plant if it is clearly brought out that all we did was to walk through the plant; but if we are to say what we think of the company's probable future and make an unqualified statement accordingly, we must not only study all details of its own business but to a certain extent the business of its competitors and all contributing factors in order to give a well considered opinion.

To assure that our reports be used only for the purpose for which they are written, we have developed the following statement which is

incorporated in the agreement with all our clients, namely: "While the report as submitted and in its entirety is the property of the client for use as the client sees fit, in accordance with our usual custom we request that it be understood that no quotation from our report or statement, or summary or opinion as expressed therein will be published unless approved by us in writing."

In my opinion that is the greatest protection that we have devised both for ourselves and our clients and saves no end of trouble and misunderstanding. This is particularly true when one realizes that, from a legal standpoint, the word "published" is susceptible to very literal interpretation, as I am informed by counsel that even speaking to one or two people about a thing is "publishing" it. This protection is not only from those who might wish deliberately to mislead, . . . but from those careless or naïve people who in an enthusiastic moment lift out a particularly good sounding paragraph which does not tell the whole story.

To summarize, I believe that there are vastly more people capable of arriving at sound opinions than there are people capable of expressing their opinions in such a way that they will be clearly and easily understood. When an engineering concern becomes established the client usually accepts their qualifications as a matter of course and the engineering concern can cease worrying about that factor, but must be continually on the alert to see that the things they say really express what they mean. One simple working rule is a second reading of any letter or report from the viewpoint of how the writer thinks it might look one year from now and under completely changed business conditions.

Another interesting thing has come up lately with regard to reports to be used in connection with the issuance of securities under the present laws. Some banking houses wish the engineer to go into elaborate detail so as to be sure that every possible subject has been covered and to show that they have used due diligence in investigating the securities which they are to sell. Other banking houses of equal prominence take the position that they should have the shortest kind of report from an engineering firm of recognized standing because they consider that their best protection lies in the fact that they have had the situation reviewed entirely independently by competent authority and have acted thereon; whereas if they accept a mass of details, they also accept some responsibility for the findings. One of the largest and most conservative banking houses invariably tells us to make any sort of studies and write as many notes as we see fit or even make a detailed voluminous report, but to keep these things in our files and only submit to them the briefest possible outlining of our findings. This is on the theory that they do not feel qualified to pass judgment upon the findings and do not wish to give the impression that they have done so, as they consider that there should not be an indefinite sharing of the responsibility but

rather a definite segregation and fixing of responsibility with regard to a specific subject. As example: we may take definite responsibility for the findings with respect to physical, operation, and general business features; the banking house will take the responsibility for the financial policies, changes in capital structure, and things of that kind; the auditing firm will take responsibility for the correctness of a company's accounts; and the law firm will take responsibility for titles and legal matters. I, personally, am heartily in accord with that procedure. . . .

2. From *The Philosophy of Customer Research,* a publication of the Customer Research Staff, General Motors, Detroit, Michigan:

Modern manufacturing methods have brought about tremendous savings to the consumer. Through modern technique products undreamed of by our forefathers have been brought into being, but as a result of large-scale operations and nation-wide distribution, producer and consumer have become more and more widely separated, so that the matter of keeping a business sensitively in tune with the requirements of the customer becomes a matter of increasing importance. Mass production and mass distribution have tended to obscure the fundamental necessity of reckoning with the detailed tastes of the individual buyer, and yet the principle is just as true today as it was back when our forefathers first began laying the foundations upon which rest our great industrial structures of today.

Customer Research is not merely a matter of sending out questionnaires—calling on car owners—compiling a lot of dull statistics—these are ONLY INCIDENTS. It's really a matter of recognizing the retail buyer as the HUB about which all our activities revolve.

From this broad viewpoint Customer Research cannot be looked upon as an isolated departmental activity. To be truly effective, it must be in the nature of a SPIRIT OR ATTITUDE OF MIND permeating every phase of a business. Or putting it still a different way, we might say that Customer Research is *simply a tool for developing a great degree of* HUMAN UNDERSTANDING. . . .

So then these are some of the reasons back of Customer Research, and will, we believe, answer most of the questions that have come to us regarding this activity.

The whole philosophy might be summarized as follows:

> If a company can ascertain concretely and in detail just what its buyers would like to have, if it can build its products in conformity with those desires and design its sales and advertising messages so that they will definitely answer the questions that are uppermost in the mind of the motorist, obviously

> there will be a continuing improvement in the merchandising processes and a broadening of the service rendered.
>
> Merchandising has been aptly defined as a problem of getting the RIGHT PRODUCT, at the RIGHT PLACE, at the RIGHT TIME, and at the RIGHT PRICE.

Customer research contributes to this end.

3. From a letter from Mr. K. G. Stuart, Market Research Department of the Eastman Kodak Company, November 10, 1937:

> I was particularly interested in your comment about our series of one-page reports entitled "Facts About Our Market." We have found them highly successful. Our management committee consists of eight men to whom we send complete reports, but in addition we have approximately a hundred executives—division heads, department heads, etc.—who are also interested in particular phases of our studies. We know from experience that they will not go through a long report. We also know the importance of any one subject can not be stressed as adequately in a complete report as when taking up a particular subject separately.
>
> A long report is seldom read at the office. It is laid aside to be put in the portfolio to be read when the executive has more time, which usually means several weeks later and at home.
>
> As you probably know, market research seldom finds new and startling facts. Its biggest job is pegging suppositions. That is, one executive will suppose that 10% of cameras in a certain class are gift cameras, another 30%, another 50%, etc. Our information determines for them a much more accurate figure. These single sheet reports are sent to the executives who are familiar with the manufacturing or sales problem discussed. Consequently, this one sheet of information means something to them.
>
> We are also hesitant in the market research department in making recommendations. We feel that we can be of greater service in the majority of cases if we present the information without recommendation in our reports. We know that our executives are familiar enough with the subject discussed to analyze the data on the basis of their own experience. . . .
>
> In this large organization, we have found that improvements are made with considerable more enthusiasm, therefore with a greater chance of success, when the ideas go up through the organization rather than down. . . .

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